



# ASPHALT

## AND ITS USES



**STANDARD-VACUUM OIL COMPANY**  
(INCORPORATED IN THE U.S.A. WITH LIMITED LIABILITY)

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# **C O N T E N T S**

	<b>Page</b>
INTRODUCTION .. ..	<b>3</b>
PROPERTIES OF ASPHALTIC PRODUCTS	<b>4</b>
MODERN PAVING EQUIPMENT ..	<b>15</b>
NOTES ON SPECIFICATIONS & ESTIMATES .. ..	<b>30</b>
CONSTRUCTION PROCEDURES ..	<b>60</b>

## **HIGHWAY SPECIFICATIONS**

SURFACE TREATMENTS .. ..	<b>75</b>
Hot Process	
Cold Process	
REPAINTING .. ..	<b>92</b>
Hot Process	
Cold Process	
REPAIRS TO POTHOLES .. ..	<b>103</b>
Hot Process	
Cold Process	

	Page
PENETRATION MACADAM (GROUT) ..	113
Hot Process	
Cold Process	
THIN PREMIXES ( $\frac{3}{4}$ " & 1") .. ..	123
Hot Process	
Cold Process	
HEAVY PREMIXED CARPETS ( $1\frac{1}{2}$ " to $2\frac{1}{2}$ ")	139
HOT-MIX HOT-LAID ASPHALTIC	
CONCRETE .. ..	148
OTHER ASPHALT SURFACES ..	181
(Airports, Tennis Courts, Driveways, Playgrounds, Footpaths, Station Plat- forms etc.)	
ASPHALT FOR INDUSTRIAL PURPOSES & WATERPROOFING .. ..	191
ASPHALT IN HYDRAULICS .. ..	205
USEFUL TABLES & DIAGRAMS ..	212

## INTRODUCTION

**T**HIS handbook is not intended to serve as an asphalt text. Its purpose is rather to present to the engineer in concise form a guide to the recommended usage of Stanvac Asphalts for Road and Airport Surfacing and selected Industrial Purposes.

Asphalt is of particular interest to the engineer because it is a powerful binder, readily adhesive, highly water-proof and durable. The technology of Asphalts is, however, too complicated and highly specialised a subject to concern the average engineer and is therefore touched on only lightly in this booklet. Included are brief descriptions of the principal tests used to classify and identify asphalt products and an interpretation of the significance of these tests, but no attempt is made to provide definitions, historical or technical background or other matter of general interest only.

In this handbook our objective has been to provide the engineer a ready reference and quick guide to the solution of some of his problems. Included in condensed form are representative specifications covering a variety of conditions encountered daily together with corresponding labour, material and cost estimates, but these necessarily are couched in general terms and are subject to variations upward and downward. For further details concerning the types of work discussed herein, and for advice concerning conditions not included, Standard-Vacuum Engineers are available for consultation on the spot. Refer to our nearest office (see p. 224) for quotations, detailed specifications and for assistance with detailed estimates.

Where conditions warrant it Standard-Vacuum Engineers will also assist in training your staff in the correct use of Stanvac Asphalts.



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## **PROPERTIES OF ASPHALTIC PRODUCTS**

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- **TERMS RELATING TO ASPHALTS**

- ● **STANVAC ASPHALTS**

- Hot Application Products

- Cold Application Products

- ● ● **TESTS FOR ASPHALTIC  
MATERIALS**

## TERMS RELATING TO ASPHALT

Asphalt is a natural constituent of many petroleum, in which it exists in solution. If the solvent oils are removed by evaporation or distillation from the crude petroleum, asphalt remains behind. This asphaltic residue is further processed by removing all impurities and hardening it to the desired consistency by blowing steam or air through it at high temperatures.

**(A) HOT APPLICATION ASPHALTS:** When supplied in their solid or semi-solid state, asphalts must be liquified by heating before they can be used and hence the term "Hot Asphalts." These products fall into one of the following two categories according to the manner in which the asphaltic residue is processed to produce them.

**1 Steam Refined Asphalts:** If the process of purifying and hardening the petroleum residue is accomplished by blowing steam through it, the products so produced are known as Steam Refined Asphalts, Paving Asphalts or Asphalt Cements. Those supplied by Standard-Vacuum Oil Company are described on page 7 following.

**2 Air Blown Asphalts:** If the process of purifying and hardening the petroleum residue is accomplished by blowing air through it, the products so produced are known as "Air Blown Asphalts" (also referred to as "Oxidized Asphalts" and "Industrial Asphalts"). Those supplied by Standard-Vacuum Oil Company are described on page 8 following.

**(B) COLD APPLICATION ASPHALTS:** Steam Refined Asphalts are sometimes manufactured into Asphalt Emulsions or Cutback Asphalts. Both types of materials as supplied by Standard-Vacuum Oil Company are generally liquid at normal atmospheric temperatures and can be used without the necessity of heating them. Hence the term "Cold Application Asphalts."

**1 Asphalt Emulsions:** Materials of this type are liquids in which a substantial amount of asphalt is suspended in water in a finely divided and stable state. When applied to a road surface an Emulsion "breaks" (that is loses its stability), the water runs off and the asphalt content remains on the road surface. The Emulsions marketed by the Standard-Vacuum Oil Company are described on page 9 following.

**2 Cutback Asphalts:** Materials of this type are solutions of asphalt in volatile or partly volatile solvents. In refinery parlance the volatiles which are distilled off during the processing of crude oil are known as "cuts." To manufacture a "Cutback Asphalt" a "cut" is put back into a prepared residual and hence the term. When applied to a road surface a cutback partly soaks in before hardening in the case of first coat work, carrying the bitumen right into the structure of the road, while when used for repainting a cutback "fluxes" with the bitumen already on the road before hardening, reviving the old bitumen on the surface. In both cases the result is a perfect bond between the newly formed carpet and the base. Cutback asphalts are designated as Rapid Curing (R.C.) Medium Curing (M.C.) and Slow Curing (S.C.) depending upon their properties.

# STANVAC HOT APPLICATION ASPHALTS

## Steam Refined Grades

### (For Road Surfacing)

	Description	Uses
Stanvac Paving Asphalt 30/40	30/40 Penetration 99.8% Bitumen 100+Ductility 52/66°C (125 to 150°F) Melting Point	(1) Penetration Macadam or Grouting (2) Premixes over 1½" (4 cm) thick.
Stanvac Paving Asphalt 60/70	60/70 Penetration 99.9% Bitumen 100+Ductility 44°/57°C (111 to 134°F) Melting Point	In lieu of 30/40 where a slightly softer product is required
Stanvac Paving Asphalt 80/100	80/100 Penetration 99.9% Bitumen 100+Ductility 42/53°C (107 to 127°F) Melting Point	(1) Surface Painting (2) Repainting (3) Seal Coats (4) Premixes (5) Semi Grout
Socosol	Cold fluid solvent for Hot Asphalts	(1) For cutting back Stanvac Paving Asphalt 30/40 or 60/70 or 80/100 to retard its setting so as to enable it to coat cold aggregates during premixing.  (2) For cutting back Stanvac Paving Asphalt 80/100.  (i) When light applications are desired in repainting over existing bituminous surfaces.  (ii) When surface painting or repainting is done under extreme cold weather conditions.
Stanvac Paving Asphalt 10/20	10/20 Penetration 99.9% Bitumen 5+Ductility 65/75°C (149 to 167°F) Melting Point	Although steam refined this grade is used mostly for waterproof paper manufacture, fillings joints in concrete slabs etc.

# STANVAC HOT APPLICATION ASPHALTS

## Air Blown Grades

(For Flooring, Roofing, Paint Manufacturing,  
Waterproofing and other Industrial Purposes)

	Description	Uses
Stanvac Industrial Asphalt 116	20/30 Penetration 99.8% Bitumen 2.5+ Ductility 80/90°C (176 to 194°F) Melting Point	(1) Roofing, built-up roofing and mastic roofing and flooring.  (2) Cementing cork insulation in refrigerating rooms.  (3) Pipe Jointing and coating of under-ground pipes.  (4) Electrical Insulation, Insu- lating papers, tapes and compounds.  (5) Damp-proof courses, water- proofing under-ground ma- sonry etc.
Stanvac Industrial Asphalt 118	8/15 Penetration 99.8% Bitumen 1+ Ductility 110/120°C (230 to 248°F) Melting Point	(1) In lieu of 116 when a harder grade is required. (2) Paint manufacture.
Stanvac Industrial Asphalt 20/25	Alternate to 116 and meets similar speci- fications	Same as Stanvac Industrial Asphalt 116.
Stanvac Industrial Asphalt 10/20	10/20 Penetration 99.8% Bitumen 1.5+ Ductility 85/95°C (185 to 203°F) Melting Point	Intermediate grade be- tween 116 and 118 and used for similar purposes.

# **STANVAC COLD APPLICATION ASPHALTS**

## **Emulsified Asphalts**

**(For Road Surfacing and Maintenance-particularly in  
Wet Weather)**

	<b>Description</b>	<b>Uses</b>
Stanvac Emulsion No. 3	Contains about 55% bitumen	(1) Surface Painting (2) Repainting and Seal Coats (3) Semi-Grout.
Stanvac Emulsion No. 6	Contains about 65% bitumen	In lieu of Stanvac Emulsion No. 3 when heavy applica- tions are preferred in sur- face painting, repainting and semi-grout. Also for premises & wet weather patch repairs.

# STANVAC COLD APPLICATION ASPHALTS

## Cutback Asphalts

(For Road Surfacing and Maintenance of all kinds)

	Description	Uses
Socofix	Rapid curing cutback RC3	(1) Surface Painting (2) Repainting (3) Mix-in-place. (4) Premixes upto 1½" (4 cm) thickness. (5) Patch repairs.
Liquid Asphalt No. 2	Slow curing cutback SC2	(1) Dust laying. (2) Low cost painting. (3) Low cost repainting (4) Reviver coats (5) Bitumen Bound Macadam.
Socofix Primer	Medium curing cutback MC0	(1) Priming waterbound stone metal of poor asphalt affinity or which is soft & friable. (2) Priming waterbound stone metal beneath surface paints or premixes where water table is high. (3) First coat on laterite, kankar, clay gravel and similar surfaces. (4) Priming under thin pre-mixes.

# **STANVAC ASPHALT SPECIALTIES**

## **Cold Application**

### **(For Roofing, Flooring, Waterproofing and Industrial Purposes)**

	<b>Description</b>	<b>Uses</b>
<b>S/V Leakfix</b>	<b>80% Bitumen content</b>	Waterproofing flat concrete or masonry roofs during dry weather.
<b>S/V Leakproof</b>	<b>65% Bitumen content</b>	Monsoon repairs to leaky concrete or masonry roofs.
<b>S/V Concrete Primer</b>	<b>45% Bitumen content</b>	(1) Priming concrete or masonry walls before applying damp-proof courses. (2) Priming concrete or steel structures before laying water-proof courses.
<b>S/V Waterproofing Paint</b>	<b>60% Bitumen content</b>	(1) Damp-proofing where thin application is desired. (2) Protective coating for metal. (3) Water-proofing concrete or masonry reservoirs
<b>S/V Plaster Bond</b>	<b>70% Bitumen content</b>	(1) Damp proof courses (2) Cold laid mastics for roofing and flooring. (3) Railway carriage roofing.

## TESTS FOR ASPHALTIC MATERIALS

No attempt will be made to describe all the tests used to classify and identify asphaltic materials, but we consider a discussion of the following to be of basic importance.

**Penetration:** The penetration test determines the hardness of a Steam Refined or Airblown Asphalt by measuring the distance that a standard needle will vertically penetrate a sample of the asphalt under controlled conditions of temperature, loading and time. The unit of penetration is 1/10 millimetre. Thus 80/100 denotes a penetration of 8 to 10 millimetres in the Standard Penetration Test in which a needle loaded with 100 grms. is allowed to penetrate for 5 secs. an asphalt sample maintained at 25°C (77°F). The lower the penetration reading the harder the asphalt, and correspondingly a high penetration reading indicates a soft asphalt. Thus an asphalt with a penetration of 30/40 is harder than an asphalt with a penetration of 60/70; an asphalt with penetration of 60/70 is harder than an asphalt with a penetration of 80/100 and so on.

**Ductility:** The ductility test records the distance in centimetres that a standard briquette of asphalt will stretch before breaking under controlled conditions of temperature and rate of pull.

This characteristic is of prime importance in asphalts used for road surfacing as without it the asphalt surface may tend to weather rapidly and tend to crack and honeycomb before the end of its normal useful life expectancy.

On the other hand, when asphalt is refined by the process of blowing air through it (Airblown Asphalt) the character of the product is radically changed. Airblown Asphalts generally have low ductility, yet strangely enough, and in contradiction to the statement

above concerning Steam Refined Asphalts, Airblown Asphalts when combined with aggregate of suitable grading and in proper proportions produce a mixture of high resilience and durability.

**Bitumen Content:** Bitumen which represents the active cementing constituent of an asphaltic product is completely soluble in carbon disulphide and therefore solubility in carbon disulphide is the usual test for an asphaltic material to determine its bitumen content. The bitumen content is thus an indication of the purity and binding qualities of asphaltic products.

Good quality pure petroleum asphalts (Steam Refined Asphalts or Airblown Asphalts) are at least 99.5 % soluble in carbon disulphide and are therefore practically pure bitumens.

The above explanation may be misleading with respect to emulsions and cutbacks where it will be observed that bitumen content is considerably lower than 99.5 %. In the case of these products it should be understood that the bitumen content represents the percentage of the bitumen incorporated in the product and not the bitumen content of the basic asphaltic product used in the manufacture of these products. In other words, the final product that is left on the road surface after the separation of solvents in cutbacks or water in emulsions when these products are used for surfacing will be the basic asphalt containing 99.9 % bitumen.

**Melting Point:** Asphalts have no definite melting point—that is there is no temperature at which they change abruptly from solids to liquids. The melting point itself is therefore better described as softening point and it can only be considered as comparative. In effect it records the temperature at which a small metal ball of known weight and dimensions will break through a sample of the asphalt held in a brass ring slightly larger in inside diameter than the diameter of the ball. The

test might be considered as an indication of the atmospheric temperature at which a film of the product might be expected to soften, but the test is inaccurate and misleading in this respect and is included in this discussion, and in the product specifications contained in this booklet, merely because some people engaged in the manufacture of bituminous paints and other industrial materials having an asphalt content, depend to some extent on this test in setting their manufacturing formulae.

**Specific Gravity:** Specific gravity of hot application asphalts at 25°C (77°F) varies between 1.00 and 1.08. For purposes of rough calculation it may be taken as 1.00.



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## MODERN PAVING EQUIPMENT

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● TRANSPORTATION OF ASPHALTS

● ● ASPHALT DISTRIBUTOR

● ● ● PAVING PLANTS

● ● ● ● SPREADERS AND FINISHERS

● ● ● ● ● ROLLERS

## **MODERN PAVING EQUIPMENT**

In building any type of road structure it is not only necessary to draw up correct specifications but also essential to ensure that the required specifications are properly implemented in the field. In the past, roads have been constructed in India mostly by manual labour, the only mechanical equipment being the road roller. However, it has always been recognised that the use of machinery for building roads, as for any other engineering construction or manufacturing process, results in speed, efficiency and high quality of work. It is appreciated that in India manual labour is available in abundance and at comparatively cheaper rates than in the Western countries, but in view of the very extensive road building programmes envisaged in India and the rapid progress of industrialization it will be increasingly more profitable and necessary to mechanise road construction. With this in view the following information is given, briefly describing the principal items of equipment required for transport and use of asphalt in road construction.

### **TRANSPORTATION OF ASPHALT:**

When asphalt is imported from abroad it is packed in steel drums which are cut open and discarded after heating and removing the asphalt. Until recently this has been the principal method of transporting asphalt in India but now that asphalt is being manufactured in the country it is expected that, in the near future, transport of asphalt in bulk by means of tank-wagons and tank trucks will be a common feature.

### **ASPHALT TANKWAGONS:**

Rail tankwagons are made in several sizes. Currently the Indian Railways propose to operate wagons of about 18 tons capacity. These wagons are normally equipped with heating arrangements using either fuel oil or steam

for the purpose of heating the asphalt on arrival at destination. The heat is conveyed through tubes or coils. The wagons are also insulated so as to minimise the loss of heat in transit. In such wagons, bulk asphalt can be transported over long distances and unloading at destination accomplished with little or no heating. The loss of heat in transit depends upon atmospheric temperatures but as a rough guide may be taken as 25°F (14°C) every 24 hours during the summer season.

Tankwagons are usually unloaded by an air compressor at a pressure of about 20 lbs. per sq. inch. The unloading time of a 18-ton tankwagon is between 10 to 15 minutes.

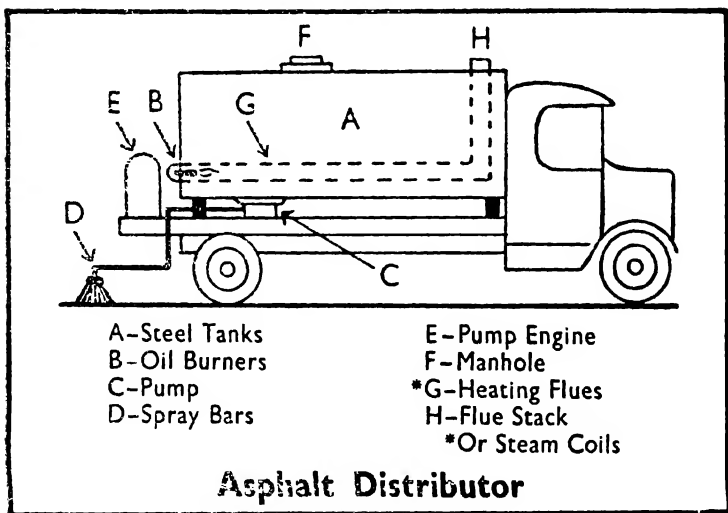
### **ASPHALT TANK TRUCKS:**

These consist of heavy steel tanks of 5-12 tons capacity mounted on trucks. The tanks should be insulated to minimise loss of heat and should be equipped with baffle plates to prevent surging. Like asphalt tankwagons these tank trucks are also equipped with similar heating and unloading arrangements. They are used to transport asphalt within the economic distance of asphalt storage or from railway station to site of work.

### **ASPHALT DISTRIBUTORS:**

When using asphalt in bulk for surface painting, penetration macadam, mix-in-place, etc. the asphalt distributor or pressure distributor becomes the most important piece of equipment. Its functions are to apply the asphalt to a prepared surface in uniform quantities and to maintain the specified rate of application irrespective of change in gradient or direction. It consists of a pneumatic tyred truck or a truck-drawn trailer on which is mounted an insulated tank or a tank with a heating arrangement. The heating is usually accomplished by oil fired burners with the direct heat from the fire box

passing through a series of flues in the tank. (Some distributors are equipped with a steam heating system). The unit is further supplied with a power driven pump of design suitable to handle products ranging from low viscosity light application asphalt cutbacks and emulsions to the heavy paving asphalts at temperatures upto 400°F (205°C). A system of spray bars and nozzles is attached at the rear end of the tank through which the asphalt is forced under uniform pressure upon the surface of the road. These spray bars should have a minimum width of application of 6 feet (about 2 metres). On larger equipment they will cover as much as 24 ft. (about 4.5 metres). A suitable thermometer should be provided so that the temperature of the asphalt in the tank may be readily ascertained at all times.



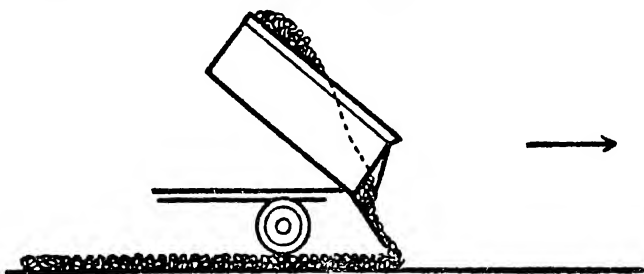
In the above illustration the pump is shown as being operated by a separate engine mounted on the rear. There are other types of distributors wherein the pump is operated by the drive shaft of the truck itself.

Distributors are made in several sizes, viz. 600, 800, 1000 and 1500 gallons capacity. The rate of application is controlled by means of a tachometer which is an instrument similar to a speedometer but very much more sensitive. The width of the spray bar being known and the rate of delivery of Asphalt through the nozzles being constant (depending upon the pump capacity) a simple calculation will indicate the tachometer reading at which the vehicle should be driven in order to apply the asphalt at the specified rate. The diagram on the opposite page shows the essential parts of one type of distributor.

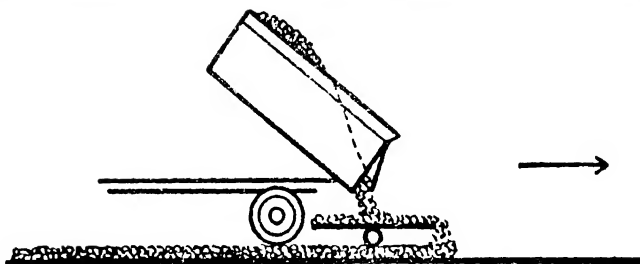
## **AGGREGATE SPREADERS:**

When Asphalt is spread by means of a pressure distributor the progress of work is much faster than what can be accomplished by manual methods. Although, for blinding it is possible to keep pace with this work by spotting aggregate along the sides of the road at frequent intervals and employing multiple gangs of labourers, it is desirable to employ mechanical means of spreading aggregate as they have the added advantage of turning out more uniform jobs.

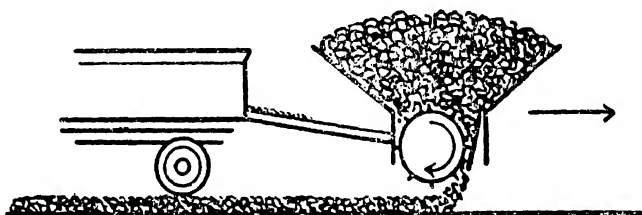
The simplest form of aggregate spreader is the vane type wherein the aggregate is spread direct from the tail gate of the truck upon a steel plate equipped with vertical vanes which distribute the aggregate uniformly over the area to be surfaced. Another type consists of a steel plate mounted on small wheels which is attached to the back of the truck. The aggregate is dumped on this mounted plate which revolves as the truck moves, whirling the aggregate over the road surface. Still a third is a hopper mounted on a steel roll with a brush set along one side to regulate the flow of aggregate as the machine moves along. These spreaders as shown in the diagram on following page are usually meant for application of thin layers as in the case of surface treatments. In spreading aggregate from such machines the



(a) Vane Spreader



(b) Whirl Spreader

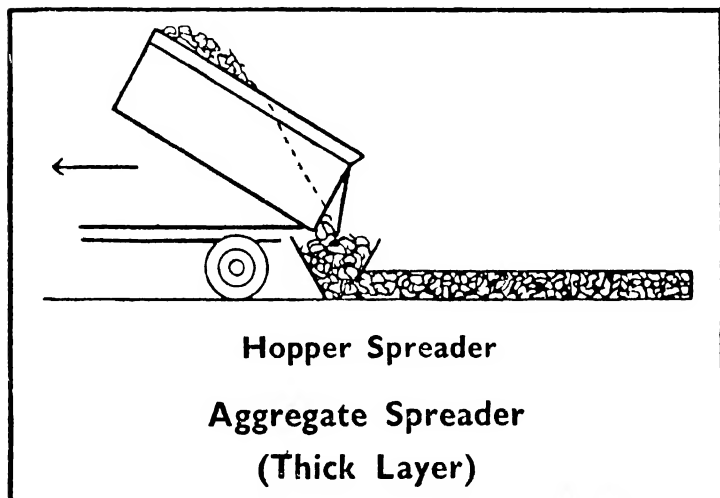


(c) Hopper Spreader  
(mounted on wheels)

**Aggregate Spreaders  
(Thin Layers)**

truck should be backed along the direction of the painting so that there is no traffic over the fresh asphalt.

For spreading aggregates in layers 1 inch (25mm) or more in thickness the hopper spreader is usually employed. It may be mounted on wheels as previously described or it may be a simple box like arrangement placed on skids as shown below.



These hopper spreaders remain on the work and are quickly attached to the truck for each unloading.

### **ASPHALT PAVING PLANTS:**

This is a plant for turning out hot mix paving mixtures and consists of (1) a drier for heating aggregate, (2) screens and bins for segregating and storing different sizes of heated aggregates, (3) asphalt heating and storage tanks, (4) proportioning devices for accurately measuring aggregate and asphalt and (5) a mechanical mixer.

## **THE DRIER:**

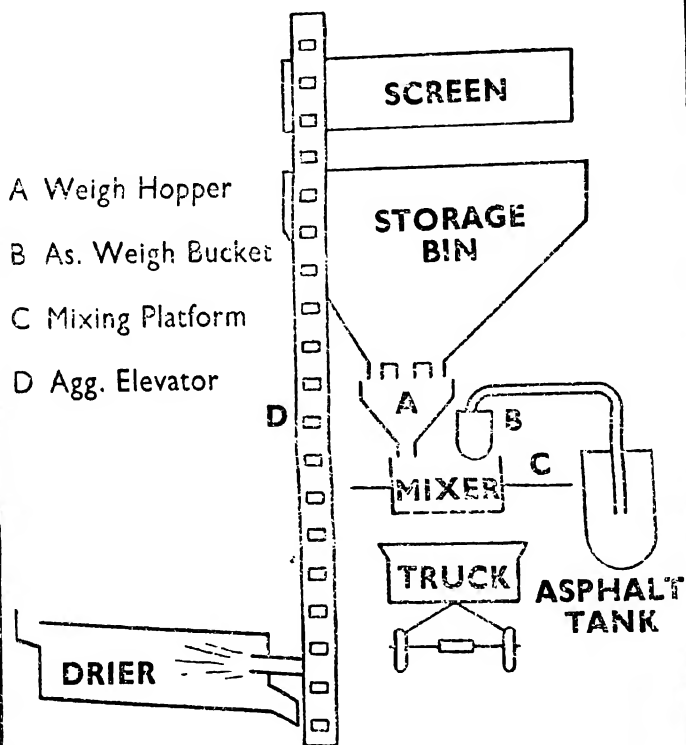
Besides drying and heating, the drier also contains arrangement for removing dust from the aggregate. It usually consists of a long cylindrical steel drum which rotates at a slight angle from the horizontal. Steel angles are fixed to the inner face of the drum and the aggregate which is fed into the upper end cascades down as the drum rotates. Hot gases for drying and heating the aggregate to the desired temperature as it passes through the drum, are usually generated by an oil burner. An electric pyrometer is installed at the discharge end of the drum to register accurately the temperature of the aggregate as it passes to the screens and hot storage bins. The capacity of the drier usually controls the plant output. It should therefore be capable of producing a dried and heated aggregate in somewhat greater volume than required to keep the mixer operating at maximum efficiency.

## **SCREENS & BINS:**

The screen is located directly above the hot storage bins. It may either be of the rotating or vibratory type. After leaving the drier the hot aggregate is passed over the screen to segregate it into suitable sizes for recombination. Each size of aggregate should be discharged into a separate bin or compartment, so constructed as to prevent overflow of one size into a bin used for another size. The bins should be equipped with discharge gates directly over the weigh hopper. The gates should be so constructed as to prevent leakage when closed.

## **ASPHALT TANKS:**

These should have storage capacity of not less than 10 hours run of the paving plant. They should not be heated by direct fire but by steam, electricity or hot oil. Steam jacketed, electrically heated or hot oil jacketed lines and connections should be provided for transfer



**Paving Plant**

of hot asphalt from the tank to the weigh bucket or volumetric meter. Continuous circulation of the hot asphalt through the draw-off pipe with return to the tank or heating kettle is desirable. Heating kettles or hot storage tanks which deliver asphalt directly to the weigh bucket or proportioning device should be equipped with thermometers and means for positive control of asphalt temperatures at all times.

## **PROPORTIONING DEVICES:**

Proportioning may be done by weight or by volume. When by weight the proportioning devices consist of a weigh box or hopper for aggregate and weigh bucket for the hot asphalt cement. The weigh box is mounted under the gates of the hot storage bins and over the mixer. It may be equipped with either a dial or beam scale, which should be sensitive to 0.5 per cent of the maximum load that may be required per batch of mix. The weigh box is usually rectangular in shape, open at the top and equipped with a full length discharge gate at the bottom so that as soon as a batch of aggregate has been weighed, it may be transferred to the mixer.

The asphalt bucket for weighing the asphalt cement should have sufficient capacity to hold not less than 20 per cent of the weight of aggregate required for one batch. It should be steam jacketed, hot oil coiled or equipped with properly insulated electric heating units to prevent accumulations of chilled asphalt from building up and changing the tare of the bucket. It should be suspended on dial scales or beam scales equipped with a tell-tale so that the tare weight of the bucket will be shown for each weighing and the net weight of asphalt cement measured accurately to within 2 per cent above or below the weight required per batch. The bucket should be so arranged that it will deliver the molten asphalt in a thin uniform sheet the full width of

the mixer. It is desirable that it have a full opening bottom discharge for its entire length. The asphalt weigh bucket is mounted on the mixer platform in such position that its contents may readily be discharged into the mixer.

When proportioning is by volume, the gradation control unit should include a feeder mounted under the hot storage bins. Each bin should have an accurately controlled individual gate to form an orifice for volumetrically measuring the aggregate drawn from each bin compartment. The orifice should be rectangular, with one dimension adjustable. Arrangements should be made so that aggregates can be by-passed to a test box, as required, to determine the accuracy of the volumetric control. Means should be provided to afford positive interlocking control between the flow of the aggregate from the bins and the flow of the asphalt from the meter or other proportioning source.

## **THE MIXER:**

The most commonly used type of mixer is known as the twin pug. It is set in the floor of the mixing platform directly under the aggregate weigh box and at an elevation sufficient to permit it to discharge into a hopper or directly into trucks which are driven under the mixing platform. The twin pug mixer consists of a rectangular steel box with an approximately semi-cylindrical bottom and an entire bottom area gate operated from the mixing platform by a hand lever or by steam or compressed air. The mixing device consists of two shafts rotating in opposite directions to which are attached removable mixing blades, set at such angles as found most efficient. The clearance of the blades from all fixed and moving parts should not exceed  $\frac{3}{4}$  inch (2 cm.), except for the coarsest asphaltic concrete base mixtures for which it should be increased to  $1\frac{1}{2}$  inches (4 cm.).

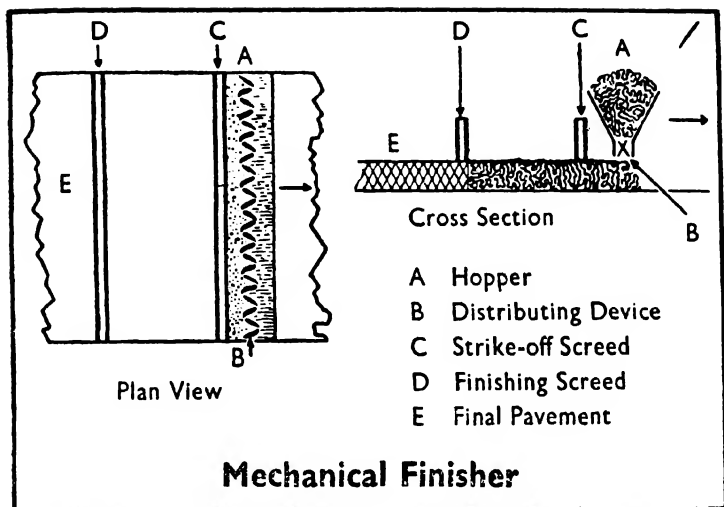
The continuous mixer employs usually the same type of twin-pug mixer as the batch type, the difference being that the batch type has closed ends while one end is open in the continuous mixer. While the required mixing time is the same for both types for a given aggregate, in the continuous mixer the material progresses through the mixer continuously with new aggregate and asphalt added at one end while the completed mixture is discharged at the other.

## **SPREADERS AND FINISHERS:**

For cold or hot laid premixes, mechanical spreading and finishing is desirable as it achieves a quality of surface far superior to hand operation.

While spreaders are of several kinds the most common consists of a hopper into which the premix is dumped. The hopper has a horizontal opening at the bottom through which the material flows out upon the surface as the spreader moves along. The object is both to speed up the work and to ensure uniformity of the layer.

Modern finishers usually combine the spreading and finishing operations in one unit. The machine consists essentially of a power driven chassis having one or more transverse operating members called screeds which place the premix to the desired cross section. It should be so operated that the mixture is spread free from lumps and of uniform density. Most machines have a hopper into which the mixture is dumped, containing either revolving blades or cutter bars which put the mixture into uniform condition in front of the finishing screed. Some types have a tamping screed which produces partial compaction in addition to spreading. The figure following shows the essential requirements of a mechanical finisher.



## ROLLERS:

The rollers currently in use in India are usually of the three wheel or the tandem type with steel faced wheels. A recent development in Western countries is the use of three axle rollers with the additional roll so arranged that a large part of the total weight of the machine may be applied thereon if required on high spots.

Three wheel rollers are used on all types of surface treatment, mix-in-place types and penetration macadam for full rolling requirements. Tandem rollers are used as finishing rollers, and on sheet asphalt are often used for full rolling requirements. By the nature of its construction a three wheel roller, of a given total weight, has a greater compression per inch width of roll than a tandem roller. Therefore, for coarse aggregate mixes where interlocking of particles is required it is able to produce a greater density under initial rolling. Rollers should not be so heavy as to crush the aggregate. For surface treatment and placement of thin layers of coarse



aggregate mixtures rollers of 5 and 8 ton weights are sufficient to produce required compaction..

A special form of steel face roller called a trench roller, is most suitable for compaction of subgrade and base courses in widening operations where the width to be rolled is too narrow for use of the conventional type roller. The roll is set in a triangular frame so that one small wheel rides the adjacent surface with the two rolls in the trench.

Pneumatic rollers are coming into wide spread use for efficient consolidation of earth subgrades and granular base courses, and also as compaction equipment in the final rolling operations for surface treatments, mix-in-place types and dense graded cold-laid premixes. These consist of a large metal container mounted on axles which are fitted with a number of rubber tyred wheels. The container is loaded with sand bags, metal weights or sometimes water so as to produce load concentrations under the tyres equal to or exceeding the loads subsequently expected under traffic. The pneumatic roller shown in the diagram is attached to a tractor but several models are available which are self-propelled.



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## SPECIFICATIONS AND ESTIMATES

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- CHOICE OF SPECIFICATIONS
- ● NOTES ON ESTIMATING
- ● ● PROPORTIONING BITUMEN  
AND AGGREGATES

General Estimate Form

Forms For Estimating

Common Types of Pavements.

## CHOICE OF SPECIFICATIONS

No engineer who has had experience in the use of Asphalts for road surfacing and maintenance will dispute the fact that it is difficult, if not impossible, to write a single standard specification for each type of asphalt surface that will be universally applicable. The type and characteristics of the existing structure, nature and cost of the mineral aggregate, climatic conditions, traffic, equipment available and funds available for improvements vary so widely that in practice many variations in standard specifications must be adopted. Our endeavour in this booklet has been to specify minimum and maximum limits per 100 sq. ft. and 1000 sq. metres and to use in our estimates what our experience indicates to be average requirements.

At the end of this Section (page 37) is a chart on which are tabulated the basic types of road structure generally encountered in the localities served by the Standard-Vacuum Oil Company through the offices listed on page 224. Opposite each type of structure is a reference to our recommendations for the asphalt surfacing of this type of structure for different densities of traffic. These are our recommendations provided sufficient funds are available for the purpose. If it is not possible to finance a surface of the type recommended then drop to a lower type of specification and improve upon it when financially in a position to do so. Do not abandon the programme, although in some cases it may be necessary to reduce the area on which you provide an improved surface in the first instance. Millions of people throughout the world have attained substantial improvement in health and material wealth through the intelligent application of this principle by the engineers entrusted with public funds. If funds are available in excess of the estimated cost of the specification recommended then increase the size of the project and give more people the benefit of the improvement rather than adopt a higher

type surface than conditions demand, at a greater cost than necessary, and on the mistaken theory that once this surfacing is completed you will have a road that is permanently improved and that will require no further attention.

That is our primary suggestion with respect to the choice of specifications. We must emphasize that the chart at the end of this section is intended as a basic guide only and that where any doubt exists in the mind of the engineer planning road improvements or maintenance, we recommend that he requests further advice from the nearest office of Standard-Vacuum Oil Company (see page 224).

Now with respect to planning where alternate possibilities must be considered we recommend the following:

**PRIMING:** Asphalt prime coat is an initial application of a low viscosity liquid asphaltic material to an absorbent surface preparatory to any superimposed treatment or construction. The object of priming is to penetrate the existing surface so as to plug capillary voids, to coat and bond dust and loose mineral particles and to promote adhesion between the original surface and the superimposed treatment.

There has been to the date of publication of this book much discussion on the subject of priming, but only limited action. Probably due to the necessity of controlling expenditures, primers are rarely specified and where they are specified, the rate of application is generally on the low side. Practice elsewhere is to use a primer under almost all conditions and generally at heavier rates of application than are ever considered in India, Burma and Ceylon. The Asphalt Institute in the United States recommends priming under almost all conditions and generally at rates equivalent to 25 to

70 lbs. per 100 sq. ft. (1.2 to 3.4 kg. per sq. metre). Exceptions occur under certain conditions when the wearing surface is to be penetration macadam or a heavy premix. Our recommendations, as given in this booklet have been made with a consideration for the limited finances so often encountered in the localities for which this booklet is intended, but we foresee in due course a wider use of primers than here-to-fore, and eventually at considerably heavier rates of application than now considered necessary or than we have recommended herein.

We recommend Priming under the following conditions:—

- 1 On surfaces such as Laterite, Kankar, brick, Clay-Gravel, or other tightly bonded surfaces.
- 2 On water-bound stone metal where the stone is of poor or doubtful asphalt affinity.
- 3 On water-bound stone metal that is soft or easily friable.
- 4 To counteract sub-soil water action in localities where the water table is high.
- 5 Before surface painting or constructing a premix carpet on cement concrete.
- 6 Before constructing a premixed carpet under any conditions to a depth of 1" (2.5 c.m.) or less.

**TACK COAT:** Asphalt tack coat is a treatment describing the initial application of asphaltic material to an existing surface to ensure thorough bond between superimposed construction and the original surface. It is usually given in the case of premixes with the same asphalt binder used in the premixes at rates varying from 10 to 20 lbs. per 100 sq. ft. (490 to 975 kg. per 1000 sqm.) depending upon local conditions and type of surface treatment.

**SEAL COAT:** Asphalt seal coat is a thin asphaltic surface treatment either of the premixed type or of the surface painting type seldom over  $\frac{1}{2}$ " (12 mm.) thick. Its purpose is to close the surface voids and make the pavement waterproof.

The application of a seal coat or course represents additional expense. The money so expended will however give substantial returns through extended life and particularly is this so in localities where there is heavy rainfall. We therefore recommend that seal coats be provided under the following conditions:—

- 1 Always before the monsoon in localities where there is heavy rainfall.
- 2 Before the monsoon in localities where there is moderate rainfall if the funds are available. If not immediately available provide the seal coat during the following dry weather.
- 3 In localities where there is light rainfall as soon as the condition of the surface indicates the seal coat is required.

**BLINDING MATERIALS:** This section, of course, has reference to the Mineral Aggregate Cover Coat used for blinding seal coats, surface paints and repaints. Our recommendations are:

- 1 Where chips are specified:
  - a—If stone is hard and chips are cubical and of good quality blind with chips only at the rates specified.
  - b—If stone is soft or easily friable then increase the quantity of blinding material by 20% and use  $\frac{2}{3}$  stone chips and  $\frac{1}{3}$  sand.

- 2 Where sand is specified always endeavour to obtain a good quality of coarse, clean sand even though at greater cost if it is available. An exception to this is when using Liquid Asphalt No. 2 for either first coat work or repainting. This product can and does absorb very fine sand particles, but if coarse sand is used it will build up a heavier carpet with its resultant advantages.

**PREMIXES:** Premix is that treatment where the aggregate is first coated with asphalt before laying. Premixes can be laid hot or cold.

**PREMIX MACADAM.** This treatment consists of mixture of graded stone metal coated with asphalt binder.

**ASPHALTIC CONCRETE:** This treatment consists of a mixture of coarse and fine aggregate coated with asphalt binder.

**PREMIX SHEET MACADAM:** In this treatment a premix macadam is followed immediately with a pre-mixed sand seal coat.

**1. Hot Asphalt vs. Cold:** As the Hot Asphalt specification involving the use of Stanvac Paving Asphalt 30/40 or 60/70 or 80/100 and Socosol will provide a premix that will set relatively quickly the hot process is always recommended for depths greater than  $1\frac{1}{2}$ " (4 cm.). For depths  $1\frac{1}{2}$ " (4 cm.) or less rapid setting is not of the same importance and in such instances cold application process using cutback asphalts and asphalt emulsions, especially the former, can be employed with advantage.

**PENETRATION MACADAM:** Penetration macadam or full grout is a type of pavement construction in which the broken stone aggregate of relatively coarse and uniform size fragments is first spread and interlocked by compaction after which the individual stones are coated and bound together with asphalt which is applied at the surface but penetrates the layer of stone before setting.

This specification, very rich in asphalt, produces a highly durable wearing surface, especially suited to bullock cart traffic.

Traffic Classification	Type of Asphalt Pavement Recommended
Light A (upto 200 tons per day)	Surface Painting (p. 76); Light treatments (p. 83 to 86)
Light B (200 to 500 tons per day)	Surface Painting (p. 76) Chipping carpet (p. 124)
Medium (500 to 1000 tons per day)	Semi grout (p. 117 to 120) Chipping carpet (p. 123) Two coat painting (p. 79; 87; 90) 1½" (4 cm.) Premixed carpet (p. 139)
Heavy A (1000 to 1500 tons per day)	Heavy carpets (p. 139) Full Grout (p. 114)
Heavy B (1500 to 5000 tons per day)	

## NOTES ON ESTIMATING

Along with the notes on each road surfacing specification contained in this handbook we have incorporated an estimate of the quantity of each material and the amount of labour required. One estimate is given for quantities per 100 sq. ft. in the units of weights and measures currently in use in India. However, as these are proposed to be replaced by the Metric System we have given another estimate expressed in the Metric System for an area of 1,000 sq. metres. We have adopted the unit of 1,000 sq. metres as our basic estimating area as the figures of quantities of materials given for this area can then be utilized in spotting materials along the road in advance of the work. The rates of application of asphalt and aggregate per 10 or 1 square metres or multiples thereof can be derived readily from this unit. We have also provided inter-conversion tables (page 212) of units from the current system to the proposed Metric System.

We have included in our estimates the completed cost for each road surfacing specification. It should be clearly understood that in no locality should these costs be taken as actuals. The object of our including the completed costs is to provide a comparison of cost between various types of Asphalt road surfacing and as a general guide for selecting an appropriate specification from financial considerations.

These cost estimates are based on the prices of Stanvac Asphalts in effect on 1st April 1958 plus assumed average cost of transport to destination (railway freight, cartage, etc.) of Rs. 30/- per long ton (1.016 metric ton). On projects located near main ports this item will be greatly reduced while on distant projects it may be appreciably enhanced. These estimates are also based on the following assumed cost of aggregate, labour, fuel and equipment and on the assumption that the minimum

extent of the road work undertaken will be about 6000 sq. metres (roughly 1 mile  $\times$  12 feet). For smaller jobs the percentage of cost represented by expense on equipment will naturally be somewhat higher although the rates of application of materials will not be affected.

	Per 100 cu.ft.	Per 10 cu.m.
Stone Metal	Rs. 50	Rs. 177
Stone Chips	Rs. 80	Rs. 283
Sand	Rs. 25	Rs. 88
Fuel	Rs. 8 per ton or	Rs. 7.84 per metric ton
	of Hot Application Asphalt	
Labour	Rs. 2 per man per day	
Boiler — rental or depreciation —	Rs. 5 per day	
Roller — operation plus rental or depreciation	Rs. 50 per day.	

Many Engineers will, of course, dispute these basic figures and it must be emphasized once again that the cost estimates contained in this handbook are included merely to provide comparisons between different types of work.

Finally, before adopting a specification for a particular project Engineers are advised to complete a detailed estimate based on the sample estimate contained on page 42. Standard-Vacuum Engineers will be glad to prepare such estimates for intending indentors if local costs of aggregate, labour, fuel and equipment are forwarded to our nearest office or they will be glad to check and advise on estimates prepared locally.

## PROPORTIONING ASPHALT AND AGGREGATE

Aggregates differ as to the quantity of asphalt they require according to grading, nature of surface (smooth or rough), degree of absorption, their degree of hardness and the percentage of dust they contain or develop during mixing. The following is therefore a rough guide only.

### PREMIXES:

Normal allowances using Stanvac Paving Asphalts 30/40 or 60/70 or 80/100 or Socofix.

	Lbs. per cu.ft.	Kgs. per cum.
2½" and 2" metal (6 cm. & 5 cm.)	2½	40
1½" and 1" metal (4 cm. & 2.5 cm.)	2½ to 3	40 to 48
¾" and ½" metal (2 cm. & 12 mm)	3 to 3½	48 to 56
¾" and ½" metal (10 mm & 6 mm)	3½ to 4	56 to 64
Coarse Sand passing 10 retained 40	4 to 6	64 to 96
Medium Sand passing 40 retained 80	6 to 8	96 to 128
Fine Sand passing 80 retained 200	8 to 10	128 to 160
Filler passing 200	10 to 15	160 to 240

NOTE: lb./cu.ft.=16 Kg./cum.

### GROUTS:

The quantity of Stanvac Paving Asphalt 30/40 or 60/70 required varies directly with the hardness of the aggregate within the following range:

	Lbs. per cu.ft.	Kgs. per cum.
For Dry French Co-efficients of		
11-15	4 to 5	64 to 80
16-20	5 to 6	80 to 96
20 and over	6 to 7	96 to 112

The quantities given are for the Grout course proper omitting the seal coat and include both the coarse and intermediate aggregates used for blinding.

NOTE: It appears curious that hard aggregates require more asphalt than soft ones. The probable reason is that those with low co-efficient crush slightly under traffic and the fine particles thus formed increase the bulk of the bitumen by forming a matrix with it.

## **SURFACE PAINTING:**

The usual practice is to allow one cu.ft. of chips for each 10 lbs. of binder (1 cu.m. per 160 Kgs.) and in the case of hot asphalt allow 10-20% chips extra.

Nearly 50% of the chips used in surface painting crush down to sand and dust. It is therefore more economical in most cases and frequently sound practice to use a percentage of sand in lieu of chips. The suggested proportions are 2/3rd chips and 1/3rd sand. The total requirements of cover aggregate will be 15-20 percent more when using sand and chips than when using chips only. The chips must be applied first and rolled before sand is spread and rolling completed.

## **REPAINTS:**

The proportion of aggregate to binder is generally 50% more than that for the original surface painting.

# ESTIMATE FORM FOR STANVAC ASPHALT ROAD CONSTRUCTION

Project No. .... Locality ..... Name of Road .....

Area = Length ..... x Breadth .....

Nature of existing surface ..... condition.....

Type of work and complete Specifications .....

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
A.	Mineral Aggregate							
1	Stone Metal 2" (5 cm.)							
2	Stone Metal 1½" (4 cm.)							
3	Stone Metal 1" (2.5 cm.)							
4	Stone Metal ¾" (2 cm.)							
5	Stone Metal ½" (12 mm.)							
6	Stone Metal ⅜" (10 mm.)							
7	Stone Metal ¼" (6 mm.)							
8	Sand .. ..							
B.	Asphalt Binder							
1	Stanvac Paving Asphalt 30/40 ..							
2	Stanvac Paving Asphalt 60/70 ..							
3	Stanvac Paving Asphalt 80/100 ..							
4	Stanvac Emulsion No. ..							
5	Liquid Asphalt No. 2							
6	Socofix .. ..							
7	Socofix Primer ..							
8	Socosol .. ..							
C.	Freight on Asphalt Binder .. ..							
1	Total quantity under Item B plus 6% tare .. ..							
D.	Cartage on Asphalt Binder .. ..							
1	Total quantity under Item B plus 6% tare .. ..							

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
E.	Octrol, Terminal Taxes etc.							
F.	Labour .. ..							
G.	Rolling charges ..							
	1 Hire of roller or depre- ciation .. ..							
	2 Driver's Wages ..							
	3 Fuel & Oil ..							
H.	Charges for Heating Asphalt .. ..							
	1 Freight on Boller..... to.....							
	2 Hire of Boller or de- preciation ..							
	3 Coal at 5 cwt. per long ton of asphalt (250 Kg per m. ton)							
I.	Mixing Plant							
	1 Hire of plant or de- preciation ..							
	2 Freight charges..... to.....							
	3 Mechanic's Wages ..							
	4 Fuel & Oil .. ..							
J.	Tools etc.							
	Wire & Bass Brooms, Buckets, Baskets, Powrahs, Picks etc							
K.	Other Items							
	Total .. ..							
	Add 5% contingencies							
	Add Contractors Profit or Departmental charges							
	<b>Grand Total...</b>							

Prepared by..... Date..... Checked by..... Date.....

# ESTIMATE FORM FOR

## 2 COAT SURFACE TREATMENT

### (HOT PROCESS)

Project No..... Locality..... Name of Road.....

Area..... 12'x1 mile .....=.....633,60 sq. ft.....

Nature of existing surface..... condition.....

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
A.	Mineral Aggregate							
1	Stone metal $\frac{1}{2}$ " size at 5 cft. per 100 sft. for first coat ..	3170	cft.			100 cft.		
2	Stone metal $\frac{1}{4}$ " size at 4 cft. per 100 sft. for second coat ..	2535	cft.			100 cft.		
B.	Asphalt Binder							
1	Stanvac Paving Asphalt 80/100 at 40 lbs. per 100 sft. for first coat and 25 lbs. per 100 sft. for second coat +2% wastage ..	18.75	Tons			Ton		
2	Sales Tax on Asphalt at .... of value ..							
C.	Freight on Asphalt							
	Total quantity under item B-1 plus 6% tare	19.9	Tons			Ton		
D.	Cartage on Asphalt							
E.	Octrol, Terminal taxes, etc.							
F.	Labour at 1 Labour day per 100 sft. of two coats .. ..	634	Man days			Day		

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
G.	Rolling Charges							
1	Hire of roller or depreciation for 6 days (including part idle time) ..	6	Days			Day		
2	Driver's and Cleaner's wages for 6 days ..	6	Days			Day		
3	Fuel and Oil for 5 days ..							
H.	Charges for heating Asphalt							
1	Hire or depreciation of boiler for 6 days	6	Days			Day		
2	Coal at 5 cwt. per ton of Asphalt ..	4.7	Tons			Ton		
I.	Small Tools Wire & Bass Brooms, Buckets, Baskets, Powrahs, etc. ..							
J.	Other Items —							
	Total ..							
	Add 5% contingencies							
	Add departmental charges or Supervision charges or Contractor's profits ..							
	Grand total for							
	633,60 sq. ft.							
	Rate per 100 sq. ft. ..							

Prepared by..... Date..... Checked by..... Date.....

# ESTIMATE FORM FOR 2 COAT SURFACE TREATMENT (HOT PROCESS) METRIC UNITS

Project No..... Locality..... Name of Road.....  
 Area..... 4 metres x 1 Kilometre=4000 sq.m.,.....  
 Nature of existing surface..... condition.....

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
A.	Mineral Aggregate							
1	Stone metal 12 mm. size at 15.25 cu.m. per 1000 sq.m. ..	61	cu.m.			100 cu.m.		
2.	Stone metal 6 m.m. size at 12 cu.m per 1000 sq.m. ..	48	cu.m.			100 cu.m.		
B.	Asphalt Binder							
1	Stanvac Paving Asphalt 80/100 at 1950 kg. per 1000 sq.m. for 1st coat and 1220 kg. per 1000 sq.m. for second coat +2% wastage .. ..	13	m.tons			m.tons		
2	Sales Tax on Asphalt at .... of value ..							
C.	Freight on Asphalt Total quantity under item B—1 plus 6% tare .. ..	13.8	m.tons			m.ton		
D.	Cartage on Asphalt ..							
E.	Octrol, Terminal Taxes, etc. .. ..							
F.	Labourt at 118 Labour days per 1,000 sq.m.	472	Man days			Day		

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
G. Rolling Charges								
1	Hire of roller or depreciation for 4 days (including part idle time)	4	Days			Day		
2	Driver's and Cleaner's wages for 4 days ..	4	Days			Day		
3	Fuel and Oil for 3½ days .. ..							
H. Charges for heating Asphalt								
1	Hire or depreciation of boiler for 4 days	4	Days			Day		
2	Coal at 250 kg. per m. ton of Asphalt ..	3.25	m.tons			m.ton		
I. Small Tools ..								
	Wire and bass brooms, Buckets, Baskets, Powrahs, etc. ..							
J. Other Items ..								
	Total ..							
	Add 5% contingencies							
	Add departmental charges or Supervision charges or Contractor's profits ..							
	Grand Total							
	for 4000 sq.m.							
	Rate per 100 sq.m.							

Prepared by..... Date..... Checked by..... Date.....

# ESTIMATE FORM FOR

## $\frac{3}{4}$ " THICK PREMIXED ASPHALT MACADAM

Project No..... Locality..... Name of Road.....

Area..... 12' x 1 Mile=633,60 sq.ft.....

Nature of existing surface..... condition.....

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
A.	Mineral Aggregate							
1	Stone Metal $\frac{1}{2}$ " size at 6 cft. per 100 sft. ..	3800	cft.			100 cft.		
2	Stone Metal $\frac{1}{4}$ " size at 3 cft. per 100 sft.	1900	cft.			100 cft.		
B.	Asphalt Binder							
1	Stanvac Paving Asphalt 80/100 for Tack Coat at 12 lbs. per 100 sft. over black topped surface or 18 lbs. per 100 sft. over W.B.M. surface +2% wastage ..	3.63	Tons					
		5.44	Tons			Ton		
2	Stanvac Paving Asphalt 80/100 for premixing at 32 lbs. per 100 sft.+2% wastage	9.23	Tons			Ton		
3	Socosol for cutting back Stanvac Asphalt 80/100 at 4% of Asphalt quantity ..	0.52	Ton					
4	Sales Tax on Asphalt and Socosol at .... of the value ..					Ton		
C.	Freight on Asphalt and Socosol .. ..							
1	Total quantity under items B—1, 2, 3 plus 6% tare .. ..	14.18	Tons			Ton		
D.	Cartage on Asphalt & Socosol .. ..							
E.	Octrol, Terminal Taxes, etc. .. ..							

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
F.	Labour at 4/5 Labour days per 100 sft. ..	507	Man days			Day		
G.	Rolling Charges							
	1 Hire of roller or depreciation for 9½ days (including 1½ idle days) ..	9½	Days			Day		
	2 Drivers & Cleaners' wages for 9½ days ..	9½	Days			Day		
	3 Fuel and Oil for 8 days							
H.	Charges for heating Asphalt							
	1 Hire of Boiler or depreciation for 9½ days	9½	Days			Day		
	2 Coal at 5 cwt. per ton of Asphalt ..	3.25	Tons			Ton		
I.	Mixing Plant							
	1 Hire of plant or mixer; or depreciation for 9½ days ..	9½	Days			Day		
	2 Mechanics Wages for 9½ days ..	9½	Days			Day		
	3 Fuel and Oil for 8 days							
J.	Small tools — Wire and bass brooms, Buckets, Baskets, Powrahs, etc.							
K.	Other items ..							
	Total ..							
	Add 5% contingencies							
	Add departmental charges or Supervision charges or Contractor's profits ..							
	Grand Total							
	for 633,60 sft.							
	Rate per 100 sft. ..							

Prepared by..... Date:..... Checked by..... Date:.....

# ESTIMATE FORM FOR

## 2 cms. THICK PREMIXED ASPHALT MACADAM

### (METRIC UNITS)

Project No..... Locality..... Name of Road.....

Area..... 4 metres x 1 Kilometre = 4000 sq. m. ....

Nature of existing surface..... condition.....

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
A.	Mineral Aggregate							
1	Stone Metal 12 m.m. size at 18.3 cu.m. per sq.m.	73.2	cu.m.			100 cu.m.		
2	Stone Metal 6 m.m. at 9 cu.m. per 1000 sq.m.	36	cu.m.			100 cu.m.		
B.	Asphalt Binder							
1	Stanvac Paving Asphalt 80/100 for Tack Coat at 590 kg. per 1000 sq.m. over black topped surface	2.40	m. tons			m.ton		
	or 880 kg. per 1000 sq.m. over W.B.M. surface +2% wastage	3.60	m. tons			m.ton		
2	Stanvac Paving Asphalt 80/100 for premixing at 1563 kg. per 1000 sq.m. +2% wastage	6.38	m.tons			m.ton		
3	Socosol for cutting back Stanvac Paving Asphalt 80/100 — 4% of Asphalt quantity .. ..	0.36	m.tons			m.ton		
4	Sales Tax on Asphalt and Socosol at ... of the value .. ..							
C.	Freight on Asphalt and Socosol .. .. Total quantity under Items B—1, 2, 3 plus 6% tare .. ..	9.7	m.tons			m.ton		
D.	Cartage on Asphalt & Socosol .. ..							

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
E.	Octrol, Terminal Taxes, etc. ..							
F.	Labour at 86 Labour days per 1000 sq.m.	344	Man days.			Day		
G.	Rolling Charges							
1	Hire of roller or depreciation for 7 days (including 1 idle day)	7	Days			Day		
2	Drivers and Cleaner's wages for 7 days ..	7	Days			Day		
3	Fuel and oil for 6 days.							
H.	Charges for heating Asphalt							
1	Hire of boiler or depreciation for 7 days	7	Days			Day		
2	Coal at 250 kg. per m.ton of Asphalt ..	2.2	m.tons			m.ton		
I.	Mixing Plant							
1	Hire or depreciation of plant or mixer for 7 days ..	7	Days			Day		
2	Mechanics Wages ..	7	Days			Day		
3	Fuel and Oil for 6 days ..							
J.	Small Tools ..							
	Wire and bass brooms, Buckets, Baskets, Powrahs, etc. ..							
K.	Other Items ..							
	<b>Total</b> ..							
	Add 5% contingencies							
	Add departmental charges or Supervision charges or Contractor's profit ..							
	<b>Grand Total</b>							
	for 4000 sq. metres							
	Rate per 100 sq.m.							

Prepared by..... Date..... Checked by..... Date.....

# ESTIMATE FORM FOR

## 1½" THICK PREMIXED ASPHALT MACADAM

Project No..... Locality..... Name of Road.....

Area..... 12' x 1 mile= 63360 sq. ft.....

Nature of existing surface..... condition.....

Item No.	ITEM	Quantity		Rate			Amount								
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.							
A. Mineral Aggregate															
1	Stone Metal 1" size 8 cu.ft. per 100 s.ft. for base course ..	5070	cu.ft.			100 cft.									
2	Stone Metal ½" size at 4 cu.ft. per 100 sft. for base course & 5 cu.ft. per 100 sft. for wearing course ..	5700	cu.ft.			100 cft.									
3	Stone Metal ¾" size at 2 cu.ft. per 100 sft. for wearing course ..	1270	cu.ft.			100 cft.									
B. Asphalt Binder															
1	Stanvac Paving Asphalt 30/40 60/70 or 80/ 100 for Premixing at 58 lbs. per 100 sft. of both courses +2% wastage .. ..	16.75	Tons			Ton									
2	Socosol for cutting back Asphalt; 6% of Asphalt quantity ..	1.0	Ton			Ton									
3	Sales Tax on Asphalt and Socosol at .... of the value ..														
C. Freight on Asphalt and Socosol .. .. Total quantity under Items B — 1, 2 plus 6% tare .. ..									18.82	Tons			Ton		
D. Cartage on Asphalt and Socosol .. ..															
E. Octrol, Terminal taxes, etc. .. ..															

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unlt.	Rs.	nP.	Per	Rs.	nP.
F.	Labour at 2 Labour days per 100 sq.ft. ..	1267	Man days			Day		
G.	Rolling Charges							
1	Hire or depreciation of roller for 18½ days including 2½ idle days	18½	Days			Day		
2	Driver's and Cleaner's wages for 18½ days	18½	Days			Day		
3	Fuel and Oil for 16 days .. ..							
H.	Charges for heating Asphalt							
1	Hire or depreciation of boiler for 18½ days	18½	Days			Day		
2	Coal at 5 cwt. per ton of Asphalt ..	4.2	Tons			Ton		
I.	Mixing Plant —							
1	Hire or depreciation of mixer or plant for 18½ days .. ..	18½	Days			Day		
2	Mechanics wages for 18½ days .. ..	18½	Days			Day		
3	Fuel and Oil for 16 days .. ..							
J.	Small Tools							
	Wire and Bass brooms, Buckets, Baskets, Powrahs, etc. ..							
K.	Other Items ..							
	Total ..							
	Add departmental charges							
	Add 5% Contingencies .. or Supervision charges or Contractor's profits							
	Grand Total							
	for 63360 sq.ft.							
	Rate per 100 sq.ft. ..							

Prepared by..... Date..... Checked by..... Date.....

# ESTIMATE FORM FOR

## 4 cms. THICK PREMIXED ASPHALT MACADAM

### (METRIC UNITS)

Project No..... Locality..... Name of Road.....

Area..... 4 metres x 1 Kilometre=4000 sq. m.....

Nature of existing surface..... condition.....

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
A. Mineral Aggregates								
1	Stone Metal 2.5 c.m. size at 24.5 cu.m. per 1000 sq.m. for Base course.	98	cu.m.			100 cu.m.		
2	Stone Metal 12 m.m. size at 12 cu.m. per 1000 sq.m. for Base course and 15.2 cu.m. per 1000 sq.m. for Wearing course ..	109	cu.m.			100 cu.m.		
3	Stone Metal 6 m.m. size at 6 cu.m. per 1000 sq.m. for Wearing course ..	24	cu.m.			100 cu.m.		
B. Asphalt Binder								
1	Stanvac Paving Asphalt 30/40, 60/70 or 80/100 for premixing at 2835 Kg. per 1000 sq.m. of both courses +2% wastage ..	11.6	m.tons			m.ton		
2	Socosol for cutting back Stanvac Paving Asphalt; 6% of Asphalt quantity ..	0.7	m.ton			m.ton		
3	Sales Tax on Asphalt and Socosol at ... of the value ..							
C. Freight on Asphalt and Socosol								
	Total quantity under items B — 1, 2 plus 6% tare ..	13	m.tons			m.ton		

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
4.	Cartage on Asphalt & Socolol. ..							
E.	Octrol, Terminal taxes, etc. ..							
F.	Labour at 188 Labour days per 1000 sq.m.	752	Man days			Day		
G.	Rolling Charges —							
1	Hire or depreciation or roller for 12½ days including 1½ idle days	12½	Days			Day		
2	Driver's and Cleaner's wages for 12½ days ..	12½	Days			Day		
3	Fuel and oil for 11 days ..							
H.	Charges for heating Asphalt ..							
1	Hire or depreciation of boiler for 12½ days	12½	Days			Day		
2	Coal at 250 kg. per m.ton of Asphalt ..	2.9	m.tons			m.ton		
I.	Mixing Plant —							
1	Hire or depreciation of mixer or plant for 12½ days ..	12½	Days			Day		
2	Mechanics Wages for 12½ days ..	12½	Days			Day		
3	Fuel and Oil for 11 days ..							
K.	Other Items ..							
	Total ..							
	Add 5% contingencies ..							
	Add departmental charges or Supervision charges or Contractor's profit							
	Grand Total							
	for 4000 sq.m.							
	Rate per 100 sq.m.							

Prepared by..... Date..... Checked by ..... Date.....

# ESTIMATE FORM FOR

## LIQUID SEAL COAT or REPAINTING

### (HOT PROCESS)

Project No..... Locality..... Name of Road.....  
 Area..... 12' x 1 Mile=633,60 sq.ft. ....  
 Nature of existing surface..... condition.....

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
A.	Mineral Aggregate							
	1 Stone metal $\frac{1}{2}$ " size at 4 cft. per 100 sft.	2535	cft.			100 cft.		
B.	Asphalt Binder							
	1 Stanvac Paving Asphalt 80/100 at 25 lbs. per 100 sft. +2% waste .. ..	7.21	Tons			Ton		
	2 Sales Tax on Asphalt at .... of value ..							
C.	Freight on Asphalt .. Total quantity under Item B—1 plus 6% tare .. ..	7.64	Tons			Ton		
D.	Cartage on Asphalt ..							
E.	Octrol, Terminal Taxes, etc. .. ..							
F.	Labour at 1/3 Labour day per 100 sft. ..	211	Man Days			Day		

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
G.	Rolling Charges ..							
1	Hire or depreciation of roller for 4½ days including ½ idle day ..	4½	Days			Day		
2	Driver's and Cleaner's wages for 4½ days ..	4½	Days			Day		
3	Fuel and oil for 4 days							
H.	Charges for heating Asphalt							
1	Hire or depreciation of boiler for 4½ days	4½	Days			Day		
2	Coal at 5 cwt. per ton of Asphalt ..	1.8	Tons			Ton		
I.	Small Tools							
	Wire and Bass brooms, Buckets, Baskets, Powrahs, etc. ..							
J.	Other Items ..							
	Total ..							
	Add 5% contingencies ..							
	Add departmental charges or Supervision charges or Contractor's profits							
	Grand Total							
	for ~ 63360 sq.ft.							
	Rate per 100 sq.ft. ..							

Prepared by..... Date..... Checked by..... Date.....

# ESTIMATE FORM FOR

## LIQUID SEAL COAT or REPAINTING

### (HOT PROCESS) METRIC UNITS

Project No..... Locality..... Name of Road.....

Area..... 4 metres x 1 Kilometre=4000 sq.m.....

Nature of existing surface..... condition.....

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
A.	Mineral Aggregate							
1	Stone Metal 12 m.m. size at 12 cu.m. per 1000 sq.m. ..	48	cu.m.			100 cu.m.		
B.	Asphalt Binder							
1	Stanvac Paving Asphalt 80/100 at 1220 kg. per 1000 sq.m. +2% wastage ..	5	m.Tons			m.ton		
2	Sales Tax on Asphalt at 3% of value ..							
C.	Freight on Asphalt Total quantity under Item B—1 plus 6% tare ..	5.3	m.tons			m.ton		
D.	Cartage on Asphalt							
E.	Octroi, Terminal taxes, etc. ..							
F.	Labour at 36 Labour days per 1000 sq.m.	144	Man Days			Day		
G.	Rolling charges —							
1	Hire or depreciation of roller for 3 days including part idle day	3	Days			Day		
2	Driver's and Cleaner's wages for 3 days ..	3	Days			Day		

Item No.	ITEM	Quantity		Rate			Amount	
		Nos.	Unit.	Rs.	nP.	Per	Rs.	nP.
	3 Fuel and Oil for 3 days							
	H. Charges for Heating Asphalt —							
	1 Hire or depreciation of boiler for 3 days							
	2 Coal at 250 kg. per m.ton of Asphalt ..	1.25	m.tons			m.ton		
	i. Small Tools — Wire & Bass brooms, Buckets, Baskets, Powrahs, etc. ..							
	Total ..							
	Add 5% Contingencies ..							
	Add departmental charges or Supervision charges or Contractor's profits							
	Grand Total							
	for 4000 sq.m.							
	Rate per 100 sq.m. ..							

Prepared by..... Date..... Checked by..... Date.....

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## CONSTRUCTION PROCEDURES

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- PREPARATION OF  
THE SURFACE
- ● APPLICATION OF  
ASPHALTS
- ● ● APPLICATION OF  
AGGREGATES
- ● ● ● PREPARATION OF PREMIX
- ● ● ● ● LAYING PREMIX
- ● ● ● ● ● GROUTING
- ● ● ● ● ● ● ROLLING

## NOTES ON CONSTRUCTION PROCEDURES

### PREPARATION OF THE EXISTING ROAD SURFACE

#### Repairs to Pot-Holes, Depressions Etc.

If the surface to be treated contains holes or depressions exceeding  $\frac{3}{4}$ " (2 cm.) in depth such irregularities should be repaired by removal of all loose and defective material and replacement with a suitable patching mixture which should be compacted to produce a tight surface conforming with the adjacent area. For patching existing bituminous surface see pages 103 to 112.

Bumps and waves which impair the riding qualities of the old surface should be removed by scarifying and recompaction.

The base to be surfaced should be well bonded, thoroughly and evenly compacted and true to established contour and grade.

**Small Tools:** Generally for all types of Asphalt work the following tools are required:—

- |                            |                    |
|----------------------------|--------------------|
| (1) Wire Brushes           | (8) Thermometer    |
| (2) Bass Brooms            | (9) Spring Balance |
| (3) Pouring Cans           | (10) Wooden Forms  |
| (4) Measuring Boxes        | (11) Hand Picks    |
| (5) Buckets                | (12) Gunny Bags    |
| (6) Screens                | (13) Camber Board  |
| (7) Platforms for Premixes | (14) Tampers       |
|                            | (15) Rakes         |

Different types of work require varying quantities of the above tools and it will be good practice generally to provide  $1\frac{1}{2}$  to  $2\frac{1}{2}\%$  of the cost of the work towards cost of small tools.

## **CLEANING THE SURFACE:**

The objective, always, is to make the base on which an asphalt treatment is to be applied as clean as possible. The cleaner the base the more assured you will be that the asphalt wearing course will adhere to the base. Any remaining film of dust or foreign matter will tend to provide an insulating medium which will afford a possible opportunity for the asphalt wearing course to slide on the base or perhaps in some cases to be lifted from it. Where Cutbacks are used this possibility is counteracted to some extent as the Cutback will soak through a film of dust or foreign matter and actually reach and grip the hard aggregate of the base. It is still advisable however, to make the base as clean as possible consistent with reasonable economy and rate of progress.

Therefore prior to the application of the asphaltic product remove all dust, dirt, caked clay, loose and foreign material for the full width to be treated by means of wire brushes, small picks, bass brooms etc. Do not mix the material so removed with cover aggregate. Take particular care to clean thoroughly the outer edges of the strip to be treated, especially, adjacent to stock piles of mineral aggregate that may have been placed on the roadway, and, if necessary, shovel back such aggregate before brooming. It is a good practice to clean the surface one foot on either side beyond the width to be treated and keep the berms well watered to prevent the dust from being blown over the surface to be treated.

## **BRUSHING THE SURFACE:**

**Water-bound Stone Metal and Broken Brick:** In the case of Water-Bound Stone Metal and Broken Brick surfaces the interstices between metal particles should be opened up to a depth of  $\frac{1}{2}$ " (12 mm.) or so by means of wire brushes or by small hand picks. This procedure is desirable in order to give an additional key to the asphalt wearing surface even when heavy carpets are

specified. After opening up the interstices the surface should be brushed with bass brooms to remove all loose matter.

**Tightly Bonded Surfaces such as Laterite, Kankar, Clay-gravel, etc.:** The use of hand picks should be avoided and if wire brushes are used at all their use should be carefully controlled and supervised to avoid tearing up the structure. The surface should be brushed with bass brooms to remove all loose dust and if there is any caked foreign matter that cannot be removed with the bass brooms, or wire brushes, perhaps a small putty knife can be used to remove it.

**Cement Concrete:** Use wire brushes to loosen any caked foreign matter and brush with bass brooms till the surface is free from dust.

**Existing Black Top Surfaces:** The surface should be swept clean of all loose foreign matter with bass brooms. Wire brushes or small hand picks should be used to loosen any foreign matter that cannot be removed by the bass brooms alone. It should be roughened if necessary by means of pick marks to afford a key if a pre-mixed carpet is to be laid over it.

## **DUSTING WITH GUNNY BAGS:**

Finally, the surface should be thoroughly dusted by beating with gunny bags to remove all remaining fine traces of dust which get dislodged while brushing and settles down in small crevices.

## **APPLICATION OF ASPHALTIC MATERIALS**

Success of a surfacing job depends largely upon the way the asphaltic materials are incorporated into the road surface. Good work requires good equipment and skilful operation. While manual labour is extensively employed throughout India, Burma and Ceylon, in the application of asphaltic materials, it is always advan-

tageous to use mechanical appliances, such as sprayers, Pressure Distributors etc. wherever possible.

## **HOT ASPHALTS:**

All hot application asphaltic materials are applied at considerably higher than atmospheric temperatures. The heating should be done in a suitably designed boiler or for small works in half cut drums or other suitable containers. In the latter case special precautions must be taken against fire hazards and overheating.

A good boiler will stand a great deal of abuse, but a little care means hard cash and better results. If left to themselves, workmen have a habit of lighting up first, and then loading with asphalt, particularly in cold weather when the asphalt flows slowly. The result is buckled plates and burnt asphalt.

Burnt or overheated asphalt is like perished rubber and useless as a binding material. Avoid the risk of it by having asphalt in the boiler before firing and by drawing fires before emptying.

Always watch temperatures carefully and do not exceed the manufacturer's recommendation, as apart from spoiling the asphalt you will probably damage the boiler also. It is a mistake to try to accelerate work by lighting too fierce a fire as there is danger of localised overheating which will cause 'Coking' at the bottom with consequent loss of efficiency.

Boilers should be cleaned thoroughly after every 200 hours working, all scale being scraped from the inside. Do not allow sharp chisels and heavy hammers to be used, otherwise the plates will be damaged.

A frequent cause of loss and delay when heating asphalt is the presence of water in the boiler which will cause foaming as soon as the temperature reaches 212°F.

(100°C) resulting in the Asphalt boiling over. In such a case the asphalt should be heated over a slow fire until the water has evaporated. Sprinkling lime over the asphalt will also help in keeping down foam.

The hot asphaltic material should be applied uniformly at a temperature of not less than 325°F. (163°C) and not more than 375°F. (190°C) on thoroughly dry surface.

Spreading hot asphalt by hand is hard work. Arrange reliefs for the brush men at frequent intervals.

Keep an eye on the temperature and be sure that fires are drawn or damped when spreading commences.

The application of hot asphalts should always be made longitudinally along the length of the road and never across it.

## **APPLICATION OF COLD CUTBACK ASPHALTS:**

All of the Cutback Asphalts supplied by Standard Vacuum Oil Company can be used, and should be used without heating them. As with all other bituminous products they are most easily applied by means of automotive pressure distributors where this equipment exists. Otherwise use a distributor made out of empty 4 gallon kerosene tin as shown on page 214. When filled to the bottom row of perforations such a distributor will hold exactly 2 gallons of Cutback Asphalt (20 lbs.) and to control the rate of application all that is necessary is to mark out on the road surface an area for each 20 lbs. to cover. It is advisable to sprinkle water on the surface at the rate not exceeding 1 gallon per 100 sq. ft. to lay the dust. There should however be no wet spots anywhere on the surface.

After the Cutback Asphalt is poured on to the road surface by means of the kerosene tin distributors it will

tend to flow together to some extent unheeded—particularly on a hot sunny day. The uniform spreading should be assisted, however, by brushing with bass brooms. The Cutback asphalt should always be poured longitudinally with the road and the brooms to spread it should be brushed back and forth horizontally across the road.

Before applying the blinding material, there should be an interval of 4 to 48 hours, to allow for penetration and partial evaporation of solvents according to the type of work carried out.

In premixes using cold cutbacks, the premixed aggregates, if stock piled and covered with tarpaulins, could be kept for periods upto 2 to 3 weeks or more without setting. This is a great advantage in carrying out patch repairs as aggregates required for patching could be premixed and stored in a central depot and distributed, as and when required, to the various patching gangs.

## **APPLICATION OF EMULSIONS:**

The road surface should be slightly dampened before applying emulsion. There should be no wet spots, but the rate of application of the emulsion can be largely controlled by the degree of dampness. Emulsion should be used without heating.

Make a "bund" 1" or 2" (2.5 to 5 cm.) high with aggregate along the kerbs to prevent the emulsion running to waste.

Roll the barrels well and mix thoroughly with a rod before drawing off any emulsion.

Emulsion may be drawn off into buckets or poured direct from the barrels on to the road and brushed to uniform coverage or spread by means of a sprayer; avoid waste.

If barrels are left open for more than a few minutes at a time, a "skin" will form on the Emulsion. See that bungs are screwed back.

Bungs should be properly tightened when stopping work even for an hour.

Do not attempt to brush over Emulsion after it has turned black; it will strip off the road. Cover with aggregates as soon as the Emulsion begins to turn black.

Brushes should be cleaned overnight, otherwise they will be unusable in the morning; ditto sprayers.

If rain falls before the Emulsion has set, spread the aggregate immediately and wait until dry before rolling or opening to traffic.

### **Protection of uncovered Asphalt surfaces:**

On no account should workmen be allowed to walk over uncovered asphalt application. They are unlikely to do so when hot asphalt is used, but are all too prone to do so on Emulsion or Cutback applications or premixes with the result that mud and dust are carried on to the surface, or the asphalt film removed.

### **Cold weather road surfacing:**

We strongly advise engineers to suspend Asphalt road construction during very cold weather, and to arrange their annual programmes to be carried out under the most favourable conditions, i.e., in warm weather.

To begin with it must be remembered that ground temperatures are frequently very much lower than air temperatures, and therefore the ground may be actually frozen even though recorded air temperatures are above freezing point. In an instance taken from the Punjab official reports, the minimum air temperature was shown

as 33°F (0.6°C) while the ground temperature was 23.6°F (-5°C).

Under such conditions asphalt will not adhere properly to an aggregate. By cooling rapidly when brought in contact with cold surfaces, a hot asphalt is extremely difficult to spread, and in the case of grouting there is no proper penetration.

## **APPLICATION OF MINERAL AGGREGATES**

To obtain smooth, uniform surface courses it is essential that the mineral aggregates be spread in a uniform manner, both in respect to rate of application and non-segregation of particle sizes. Upon completion of treatment, no loose aggregate should be allowed to remain on the pavement.

When for any reason it is desired to finish one half width of surface treatment at a time the mineral aggregate should be spread only to within 8" (20 cm.) of the inside edge of Asphalt application until the asphaltic material is spread to the remaining half of the surface.

### **Surface painting, repainting and seal coats:**

In surface painting, seal coating over grout etc., it is very difficult to spread chips uniformly by hand and the result is unequal compression under rolling. The low spots where chips are deficient get no rolling at all, while the high spots containing surplus chips are subjected to excessive pressure. Uneven distribution is also a waste of material as all surplus is whipped away by traffic. To ensure uniform distribution of the blinding and to obtain a smooth riding surface, we recommend the use of a dragbroom such as that illustrated on page        or a mechanical aggregate spreader.

The quantities given are only approximate and local materials may be used to save expense.

Where blinding with sand is specified, no rolling is necessary and the excess sand remaining on the surface may be swept off after about a fortnight.

## **PREPARATION OF PREMIX**

**Hot Cutback Process using Stanvac Paving Asphalt 30/40 or 60/70 or 80/100 and Socosol:** For all types of Premix with hot asphalt, it is necessary either to heat the aggregate to the same temperature as the asphalt or add a solvent to the asphalt to retard its setting and thus enable it to coat cold aggregates. The latter method is known as the "Hot Cutback Process" of preparing premixes.

In this process, either the straight grade of asphalt cutback with a solvent added at site or a ready mixed product containing a predetermined quantity of solvent in asphalt may be used.

Our experience proves that far better results are obtained if a solvent is added to the molten asphalt just before it is poured into the mixer for mixing with the aggregates. Therefore instead of supplying a ready mixed product we prefer to supply separately our straight grades, Stanvac Paving Asphalt 30/40 or 60/70 or 80/100 and the required quantity of solvent Socosol for cutting back the straight grade.

The percentage to be used varies from 3% to 10% according to weather conditions; for conditions generally met with in India, Ceylon and Burma, we have found that an average of one ounce per pound of molten asphalt is quite adequate. To determine the percentage of Socosol, try a few experimental batches, starting with 3% Socosol in the Asphalt. If the aggregates are not properly coated increase the Socosol content gradually until a good mix is obtained. It will never be necessary to use Socosol in excess of 4 to 6% during summer.

The chief advantage in this method is that the quantity of volatile solvent used can be controlled effectively

which is a very important factor in laying premixed carpets, as best results are obtained when no more or no less of the required quantity of the solvent is used to perform its function, viz., of retarding the setting of the asphalt just sufficiently long to enable it to coat cold aggregates. If an excess of solvent is present in the asphalt, the carpet is likely to remain soft for a considerable period which would result in the formation of corrugations. If, on the other hand, the percentage of the volatile solvent is too low the aggregate will not get uniformly coated with asphalt which would result in a weak carpet. These defects may occur if premix works are carried out with a ready mixed product where the percentage of solvent is predetermined theoretically for general conditions.

### **Cold Cut-back and Emulsion Premixes:**

For cold premixes, Socofix and Stanvac Emulsion No. 6 are used without the application of heat.

A convenient and economical method of premixing aggregates with Socofix for small works is by means of locally made barrel mixers. Particulars of this type of mixer can be obtained from the nearest office of Standard-Vacuum Oil Co.: (See page 224). For very small works premixing could be carried out on a clean platform using shovels. For large works use a power driven mixer.

For preparing premixes with Stanvac Emulsion No. 6 the aggregates are loaded into perforated buckets which are immersed for a few minutes in the emulsion kept in a larger container. Each particle becomes evenly coated by this method and after the excess emulsion is allowed to drain away, the coated aggregates are spread on the road ready for compaction. Mixing could also be carried out on a clean platform using shovels.

## **Plant for Premixing**

For large premixing works specially with hot cut-back asphalt binder a power driven Pug Mill Mixer is recommended.

For smaller works locally made barrel mixers may be used for Macadam Type of premixes using cut-back asphalt binder. These mixers are however unsuitable for premixing asphaltic concrete type of premixes using cut-backs for which only the Pug Mill type should be used to ensure proper coating of the sand particles with asphalt.

For very small works, Socofix or Emulsion premixes can be prepared on a clean platform using shovels.

## **LAYING PREMIXES**

Kerbs are not necessary for 1" ( $2\frac{1}{2}$  cm.) pavements, but should be provided for greater thicknesses. If at the time of laying the carpet permanent kerbs have not been constructed, suitable side forms of wood or steel should be firmly fastened in place, true to line and grade. These forms should remain in place until final compaction has been obtained and the mixture has hardened. Immediately after forms are removed, paint the exposed edges of the pavement with asphalt to seal all voids after which permanent kerbs should be provided.

If permanent kerbs are provided before laying the premix the inside edge of the kerb should be painted with the binder used in the premix before laying the carpet. Paint also the edges of manhole covers or any other surfaces coming in contact with the premixed carpet to seal the joints against the entry of moisture.

If the pavement is constructed in half widths, a temporary wooden form should be set along the centre line during laying and rolling.

All premixes prepared by the hot cutback method using Stanvac Paving Asphalt 30/40, 60/70 or 80/100 and Socosol or with Stanvac Emulsion No. 6 should be laid immediately after premixing on the prepared base. Premixes with Socofix may be prepared in advance and allowed to cure for about 2 days before laying.

The premix should not be dumped on the prepared surface from wheel barrows. It should first be placed on a clean metal sheet or platform outside of the area to be surfaced and shovelled on to the surface and raked to the desired loose thickness at rates specified. The raking must be carefully and skilfully done in such a manner that after the first passage of the roller over the raked mixture a minimum amount of back patching would be required.

To enable the solvent used in cutting back the asphalt to evaporate before compaction, roll only after an interval of 3 to 6 hours a hot cutback premix: and after an interval of 8 to 12 hours a Socofix premix.

Laying of the mixture should be as continuous as possible and the roller should pass over the unprotected edge of the freshly laid mixture only at the end of the day's work and construction joints should be formed at such places.

**Joints:** Joints between old and new pavements or between successive day's work on the same course, should be made in such a manner as to insure a thorough and continuous bond between the old and new surfaces. Except when a canvas rope joint is used, the edge of the old course should be cutback to its full depth, so as to expose a fresh surface which should be painted lightly with the cutback binder used in the premix after which the fresh mixture should be placed in contact with it, and spread to the proper depth and grade.

## **GROUTING OR PENETRATION MACADAM**

The foundation underneath grout should be capable of withstanding the heaviest traffic to which it will be subjected.

Care should be taken to see that all aggregates used are clean and dry and also that the old surface is cleaned properly and dry.

During rolling of the coarse aggregate the surface should be examined and metal added and removed as necessary to obtain uniformity.

The temperature of the asphalt should be kept between 350°F and 375°F (177 to 190°C) and the areas should be marked out roughly to verify rate of application.

As soon as the asphalt is applied, the intermediate aggregate should be spread and the surface rolled hard with a drag broom behind the roller. If no drag broom is available, have coolies with bass brooms to spread out the loose intermediate aggregate.

When all movement under the roller has ceased, the surface should be brushed lightly. If dragging has been properly carried out, there should be practically no loose aggregate on the surface.

The seal coat should now be applied and covered with chips and the surface rolled and dragged until thoroughly bonded.

Kerbs should be provided for lateral support.

## **ROLLING**

Rolling should always proceed in a longitudinal direction beginning at the outer edge and working towards

the centre, each trip over-lapping the previous trip by about one half the width of the rear wheel.

The speed of the roller should be sufficiently slow to prevent any pushing under the wheels.

In the rolling of premix carpets to prevent the mixture sticking to the wheels of the roller, the wheels should be cleaned thoroughly and rubbed with an oily cloth to produce a thin film of oil or kept slightly moist with water. The use of excessive quantities of oil or water for this purpose should be avoided. Should the mixture push ahead of the roller, rolling should immediately be discontinued until the mixture has sufficiently cured to overcome any such tendency. Should any part of the surface show an excess of voids, low spots or depressions, sufficient surfacing mixture should be added to correct the defective areas and rolled into the body of the pavement.

Along Kerbs, manholes etc. and at all places not accessible to the roller, thorough compaction should be secured by means of tampers and at all contacts of this character the joints between these structures and surface mixture should be effectively sealed.



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## **SURFACE TREATMENTS**

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- **HOT PROCESSES**

- Single Coat Surface Painting

- Two Coat Surface Painting

- ● **COLD PROCESSES**

- Priming Coats

- Dust Laying on Waterbound Stone Metal

- Treatment of Broken Brick Surfaces

- Treatment of Laterite, Kankar,

- Clay, Gravel, etc.

- Two Coat Surface Painting with Emulsion

- Two Coat Surface Painting with Socofix.

# SINGLE COAT

## SURFACE PAINTING ON STONE METAL

### (Hot Process)

**A. GENERAL DESCRIPTION:** This specification provides for the asphalt surface treatment of a well consolidated waterbound stone metal structure with a single application of Stanvac Hot Application Asphalt, blinded with stone chips and rolled.

**B. MATERIALS REQUIRED:**

	Per 100 sq. ft.	Per 1000 sq.m
Stanvac Paving Asphalt		
80/100	40 to 45 lbs.	1950 to 2200 kg.
Stone Chips		
$\frac{1}{2}$ " (12mm.)	size 5 cu.ft.	15.25 cu.m.

**C. LABOUR REQUIRED:**

Labourer days	$\frac{3}{4}$	82
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**D. EQUIPMENT REQUIRED:**

Roller (5 to 8 tons)

Boiler

Small Tools (Page 61)

**E. ESTIMATED COST COMPLETE:**

Rs. 14 $\frac{1}{2}$	Rs. 1560/-
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NOTE: Roller: One roller can roll 15,000 to 20,000 sq. ft. (1,400 to 1,800 sq. m.) per day.

Boiler: One boiler can heat 1 $\frac{1}{2}$  to 2 charges daily.

Under extreme cold weather conditions it is advisable to cutback Stanvac Paving Asphalt 80/100 with about 3 to 6% of Socosol.

**F. PROCEDURE:** (All pot-holes and depressions in the surface should be repaired one week or so before work is commenced—Page 61).

1. Brush the surface clean using wire brushes and bass brooms to loosen all caked and foreign matter and to open up the interstices between the metal particles to a depth of  $\frac{1}{2}$ " (12 mm.) or so. (Page 62).
2. Dust the surface with gunny bags to remove the remaining loose dust. The base should be absolutely dry and clean before the asphalt is applied. (Page 63).
3. Apply the asphalt by means of suitable sprayer equipment or by the usual type of lipped pouring bucket. The asphalt should be heated to 325°F to 350°F (163 to 177°C). Apply longitudinally along the road. (Page 64).
4. Cover with stone chips. (Page 68).
5. Roll immediately. (Page 73).
6. Open to traffic.
7. Broom and back-roll on following day.

## ALTERNATES

- (a) **Soft Stone Chips**—If the stone chips available are soft, then a combination of chips and sand rather than chips alone is recommended for blinding. Requirements will be:

	Per 100 sq. ft.	Per 1000 sq.m
$\frac{1}{2}$ " (12 mm.) Stone Chips	4 cu. ft.	12 cu.m.
Sand	2 cu. ft.	6 cu.m.

NOTE: The chips must be applied first and rolled before the sand is spread (see page 41).

- (b) **Use of Primer**—If a Primer is specified eliminate steps 1 and 2 and follow the procedure described on pages 81 and 82 before applying the hot asphalt according to steps 3, 4 and 5 above. See page 32 for conditions under which priming is recommended.

## TWO COAT SURFACE TREATMENT

(Hot Process)

**A. GENERAL DESCRIPTION:** This specification provides for the asphalt surface treatment of a well consolidated waterbound stone metal structure with two applications of Stanvac Paving Asphalt 80/100 blinded with stone chips and rolled. This specification is recommended in lieu of Single Coat Surface Dressing where a more durable wearing surface is desired.

**B. MATERIALS REQUIRED:**

	Per 100 sq.ft.	Per 1000 sq.m.
Stanvac Paving Asphalt 80/100		
First coat	35 to 40 lbs.	1700 to 1950 kg.
Second coat	25 to 30 lbs.	1220 to 1470 kg.
Stone chips		
First coat $\frac{1}{2}$ " (12 mm.) size	5 c.ft.	15.25 cu.m.
Second coat $\frac{1}{4}$ " (6 mm.) size	3 to 4 c.ft.	9 to 12 cu.m.

**C. LABOUR REQUIRED:**

Labour days —

First coat	3/4	82
Second coat	1/3	36

**D. EQUIPMENT REQUIRED:**

Roller (5 to 8 tons)

Boiler

Small Tools (Page 61)

**E. ESTIMATED COST**

COMPLETE	Rs. 23	Rs. 2475
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Under extreme cold weather conditions it is advisable to cutback Stanvac Paving Asphalt 80/100 with 3% to 6% of Socosol.

- F. PROCEDURE:** (All pot holes and depressions in the surface should be repaired one week or so before work is commenced — page 61).

**First Coat** —1. Follow the procedure given on page 76 for the first coat.

**Second Coat**—(a) After the first coat has been under traffic for three weeks or more brush the surface clean to remove all loose and foreign matter. The surface should be absolutely dry and clean before the asphalt is applied.

(b) Apply the asphalt by means of suitable sprayer equipment or by the usual type of pouring can. The asphalt should be heated to 325°F to 350°F (163 to 177°C). Apply longitudinally along the road.

(c) Cover with  $\frac{1}{4}$ " (6 mm.) stone chips.

(d) Roll immediately.

(e) Open to traffic.

(f) Broom and back roll on following day.

**NOTE:** If treatment with asphalt is desired during the construction of the water-bound stone metal structure follow procedure on page 117 or 120.

## **PRIMING COATS**

### **(Cold Process)**

**A. GENERAL DESCRIPTION:** This specification provides for the asphalt priming of a surface not previously treated with a bituminous product and consists of an application of Socofix Primer applied cold. This specification in itself does not provide a wearing surface and it is accordingly to be used only when it is to be followed at once by an application of a heavier asphalt product in the form of a surface paint, or when a premix is to be laid immediately. It is recommended under the following conditions:—

1. On surfaces such as laterite, kankar, brick, clay-gravel or other tightly bonded surfaces.
2. On waterbound stone metal where the stone is of poor or doubtful asphalt affinity.
3. On water bound stone metal that is soft or easily friable.
4. To counteract sub-soil action in localities where the water table is high.
5. Before surface painting or constructing a premix carpet on cement concrete.
6. Before constructing a premixed carpet under any conditions to a depth of 1" (2.5 cm.) or less.

**B. MATERIALS REQUIRED:**

	Per 100 sq.ft.	Per 1000 sq.m.
Socofix Primer	15 to 30 lbs.	735 to 1470 kg.

**C. LABOUR REQUIRED:**

Labourer days	4	27
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**D. EQUIPMENT REQUIRED:**

Small Tools (Page 61)

No Boiler—No Roller

**E. ESTIMATED COST**

COMPLETE:	Rs. 4½	Rs. 485
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**F. PROCEDURE:** (All pot-holes and depressions in the surface should be repaired one week or so before work is commenced—Page 61).

1. Brush the surface clean (Page 62).
2. Dampen the surface very lightly with water to lay the remaining dust. (Page 65).
3. Apply Socofix Primer by means of sprayer or "kerosene tin distributors." See Page 214 for diagram and instructions for use. The perforations should be made according to note B(2). Socofix Primer should be applied without heating.
4. Brush Socofix Primer to uniform coverage with bass brooms. (Page 65).
5. Allow Socofix Primer to penetrate completely before proceeding with the wearing surface. Any excess primer lying on the surface should be brushed out with bass brooms and additional time allowed for it to penetrate, or else it should be blotted up with gunny cloth.

# **LOW COST ASPHALT SURFACING OF WATER- BOUND STONE METAL, BROKEN BRICK AND SIMILAR SURFACES—Dust Laying (Cold Process)**

**A. GENERAL DESCRIPTION:** This specification provides for the low cost asphalt surfacing of well consolidated structures of the type described, or of other similar types of surfaces, by an application of Liquid Asphalt No. 2 blinded with sand. Its effect is not to produce a heavy wearing carpet but rather to stabilize the blinding material between the metal particles and thus prevent the structure from unraveling. Surfaces so treated can be maintained at low cost in the manner described on page 97. Liquid Asphalt No. 2 is used without heating.

## **B. MATERIAL REQUIRED:**

	Per 100 sq. ft.	Per 1000 sq.m
Liquid Asphalt No. 2	20 to 30 lbs.	975 to 1470 kg.
Local Sand	2 to 3 cu. ft.	6 to 9 cu.m.

## **C. LABOUR REQUIRED:**

Labourer days	1/3	36
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## **D. EQUIPMENT REQUIRED:**

Small Tools (Page 61)

No Boiler—No Roller

## **E. ESTIMATED COST**

COMPLETE:	Rs. 6½	Rs. 700
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**F. PROCEDURE:** (All pot-holes and depressions in the surface should be repaired one week or so before work is commenced—Page 61).

1. Brush the surface clean but not sufficiently hard to disturb or loosen the surface particles of the structure. (Page 62).
2. Dampen the surface very lightly with water to lay the remaining surface dust. (Page 65).
3. Apply Liquid Asphalt No. 2 by means of sprayer or "kerosene tin distributors." [See Page 214 for diagram and instructions for use. The perforations should be made according to Note B (1).] Liquid Asphalt No. 2 should be applied without heating.
4. Brush Liquid Asphalt No. 2 to uniform coverage with bass brooms. (Page 65).
5. Allow time for Liquid Asphalt No. 2 to partially penetrate into the surface. Generally 4 to 24 hours will be required but 1 hour may be sufficient on broken brick. (Page 65).
6. Cover with sand. (Page 68).
7. Open to traffic as soon as the sand is applied. No rolling is required.

**NOTE:** If it is desired to build up an asphalt wearing carpet on the metal follow one month later with an application of Stanvac Paving Asphalt 80/100 according to the procedure on page 93.

# **ASPHALT SURFACING OF LATERITE, KANKAR, CLAY-GRAVEL AND SIMILAR SURFACES**

## **(Cold Process)**

**A. GENERAL DESCRIPTION:** This specification provides for the low cost asphalt surfacing of tightly bonded roadways or footpaths of the type described, or of other similar types of surfaces, by a priming coat of Socofix Primer and a wearing surface of Socofix blinded with sand.

**B. MATERIALS REQUIRED:**

	Per 100 sq.ft.	Per 1000 sq.m
Socofix Primer	15 to 25 lbs.	735 to 1220 kg.
Socofix	10 to 15 lbs.	490 to 735 kg.
Local Sand	2 cu. ft.	6 cu.m.

**C. LABOUR REQUIRED:**

Labourer days	$\frac{1}{2}$	54
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**D. EQUIPMENT REQUIRED:**

Small Tools (Page 61)

No Boiler—No Roller

**E. ESTIMATED COST**

COMPLETE:	Rs. 8 $\frac{1}{2}$	Rs. 915
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- F. PROCEDURE:** (All pot-holes and depressions in the surface should be repaired one week or so before work is commenced—Page 63).
1. Brush the surface clean but not sufficiently hard to disturb the surface particles of the structure. (Page 63).
  2. Dampen the surface with water. (Page 65).
  3. Apply Socofix Primer by means of sprayer or "kerosene tin distributors." (See Page 214 for diagram and instructions for use. The perforations should be made according to Note B(2).) Socofix Primer should be used without heating.
  4. Brush Socofix Primer to uniform coverage with bass brooms. (page 65).
  5. Allow sufficient time for Socofix Primer to soak in completely (one to four hours will often be sufficient but allow more time if necessary). (Page 65).
  6. After Socofix Primer has soaked in apply Socofix at the specified rate using kerosene tin distributors made according to Note B(1) on Page 215. Socofix should be used without heating.
  7. Brush Socofix to uniform coverage with bass brooms. (Page 65).
  8. Allow 1 to 4 hours and then cover with sand. (Page 68).
  9. Open to traffic as soon as sand is applied. No rolling is required.

**NOTE:** If a heavy carpet is desired eliminate steps 6, 7, 8 and 9 and follow the procedure for Repainting on page 93 (Eliminate Steps F1 & F2 on page 94).

# **SURFACE PAINTING ON STONE METAL**

## **(Cold Process)**

### **(Two Coat Surface Painting with Emulsion)**

A. **GENERAL DESCRIPTION:** This specification provides for the asphalt surface treatment of a well consolidated waterbound stone metal structure with two applications of Stanvac Emulsified Asphalt blinded with stone chips and rolled.

B. **MATERIALS REQUIRED:**

	Per 100 sq.ft.	Per 1000 sq.m
Stanvac Emulsion No. 3		
First Coat	30 to 40 lbs.	1470 to 1950 kg.
Second Coat	20 to 30 lbs.	975 to 1470 kg.

Stone Chips—

First Coat $\frac{1}{2}$ " (12 mm.) size		
3 to 4 cu.ft.		9 to 12 cu.m.
Second Coat $\frac{1}{4}$ " (6 mm.) size		
or Coarse Sand 2 to 3 cu.ft.		6 to 9 cu.m.

C. **LABOUR REQUIRED:**

Labourer days—		
First Coat	2/3	72
Second Coat	1/4	27

D. **EQUIPMENT REQUIRED:**

Roller (5 to 8 tons)  
Small Tools (Page 61)

E. **ESTIMATED COST**

COMPLETE:	Rs. 18½	Rs. 1990
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NOTE: One roller can roll 15,000 to 20,000 sq. ft. (1,400 to 1,800 sq. m.) daily of either first coat or second coat.

F. PROCEDURE: (All pot-holes and depressions in the surface should be repaired one week or so before work is commenced—Page 61).

### 1. First Coat:

- a—Brush the surface clean, using wire brushes and bass brooms to loosen all caked and foreign matter and to open up the interstices between the metal particles to a depth of  $\frac{1}{2}$ " (12 mm.). (Page 62).
- b—Dust the surface with gunny bags to remove the remaining loose dust. (Page 63).
- c—Dampen the surface with water. (Page 66).
- d—Apply the emulsion by means of a suitable spraying equipment or by the usual type of lipped pouring bucket. The emulsion should be used without heating. (Page 66).
- e—As soon as the emulsion breaks (turns black) cover with stone chips. (Page 67). Do not brush after emulsion has started to break.
- f—Roll and open to traffic after 4 to 6 hours.

### 2. Second Coat:

- a—After the first coat has ironed out under traffic for three weeks or more brush the surface clean to remove all loose and foreign matter. (Page 63).

b—Apply the emulsion by means of suitable spraying equipment or by the usual type of lipped pouring bucket. The emulsion should be used without heating. (Page 66).

c—As soon as the emulsion breaks (turns black) cover with stone chips. (Page 67).

d—Roll and open to traffic after 4 to 6 hours. (Page 73).

NOTE: If heavier applications are desired Stanvac Emulsion No. 6 may be used instead of Stanvac Emulsion No. 3.

## **SURFACE PAINTING ON STONE METAL**

### **(Cold Process)**

#### **(Two Coat Surface Painting with Socofix)**

**A. GENERAL DESCRIPTION:** This specification provides for the asphalt surface treatment of a well consolidated waterbound stone metal structure with two applications of Socofix blinded with stone chips and rolled.

#### **B. MATERIALS REQUIRED:**

	Per 100 sq. ft.	Per 1000 sq.m
Socofix—		
First Coat	30 to 35 lbs.	1470 to 1710 kg.
Second Coat	15 to 20 lbs.	735 to 975 kg.
Stone Chips—		
First Coat $\frac{1}{2}$ " (12 mm.)	4 to 5 cu. ft.	12 to 15.25 cu.m.
Second Coat $\frac{1}{4}$ " (6 mm.)	2 to 3 cu. ft.	6 to 9 cu.m.

#### **C. LABOUR REQUIRED:**

Labourer days—		
First Coat	2/3	72
Second Coat	$\frac{1}{4}$	27

#### **D. EQUIPMENT REQUIRED:**

Small Tools (Page 61)  
Roller (5 to 8 tons)

#### **E. ESTIMATED COST**

COMPLETE:	Rs. 18	Rs. 1940
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**NOTE:** One roller can roll 15,000 to 20,000 sq. ft. (1,400 to 1,800 sq. m.) daily of either first coat or second coat.

**F. PROCEDURE:** (All pot-holes and depressions in the surface should be repaired one week or so before work is commenced—Page 61).

**1. First Coat:**

- a—Brush the surface clean, using wire brushes and bass brooms to loosen all caked mud and foreign matter and to open up the interstices between the metal particles to a depth of  $\frac{1}{2}$ " (12 mm.) or so. (Page 62).
- b—Dust the surface with gunny bags to remove the remaining loose dust. (Page 63).
- c—Dampen the surface very lightly with water to lay the remaining surface dust.
- d—Apply Socofix by means of sprayer or "Kerosene tin distributors. [See Page 214 for diagram and instructions for use. The perforations should be made according to Note B (1).] Socofix should be used without heating.
- e—Brush Socofix to uniform coverage with bass brooms. (Page 65).
- f—Cover with Stone Chips. (Page 68).
- g—Roll and open to traffic on following day. (Page 73).

**2. Second Coat:**

(To be applied after the first coat has been under traffic for 2 to 3 months and has completely ironed out).

- a—Brush the surface clean to remove all loose and foreign matter. (Page 63).
- b—Apply Socofix by means of sprayer or kerosene tin distributors and brush to uniform coverage. (Page 65).
- c—Cover with Stone Chips. (Page 68).
- d—Roll and open to traffic after 4 to 6 hours. (Page 73).



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## REPAINTING

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- HOT PROCESSES

- Over Normal Surface

- Over Highly Polished Surface

- COLD PROCESSES

- Repainting with Emulsion

- Reviver Coat over Smooth Riding  
Surface

- Reviver Coat over

- Slightly Rough Surface

- Repainting a Corrugated  
Surface (Mix-in-Place).

## REPAINTING

### (Hot Process)

A. GENERAL DESCRIPTION: This specification provides for the repainting of bituminous surfaces with a single application of Stanvac Hot Application Asphalt blinded with stone chips.

B. MATERIALS REQUIRED:

	Per 100 sq. ft.	Per 1000 sq.m.
Stanvac Paving Asphalt		
80/100	25 to 30 lbs.	1220 to 1470 kg.
Stone Chips		
$\frac{1}{2}$ " (12 mm.) size	3 to 4 cu. ft.	9 to 12 cu.m.

C. LABOUR REQUIRED:

Labourer days	1/3	36
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D. EQUIPMENT REQUIRED:

Roller (5 to 8 tons)  
Boiler  
Small Tools (Page 61)

E. ESTIMATED COST

COMPLETE:	Rs. 8½	Rs. 915
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NOTE: One roller can roll 15,000 to 20,000 sq. ft. (1,400 to 1,800 sq.m.) daily. Each boiler can heat 1½ to 2 charges daily.

**F. PROCEDURE:** (All pot-holes should be repaired about one week or so before commencing the work preferably by the procedure described on page 107 or 110 but by the procedure described on page 104, if the use of the hot asphalt is preferred.

1. Brush the surface clean using wire brushes and bass brooms to remove all caked and foreign matter. (Page 63).
2. Dust with gunny bags to remove the remaining loose dust.
3. Apply asphalt by means of suitable sprayer equipment or by the usual type of lipped pouring bucket at a temperature of 325° to 350°F (163 to 177°C). Pour longitudinally along the road. (Page 64).
4. Cover with Stone Chips immediately. (Page 68).
5. Roll with a power roller. (Page 73)
6. Open to traffic.

### **ALTERNATES**

- (a) **Corrugated Surface:** If the surface is badly corrugated follow the procedure described on page 101 (Mix-in-Place with Socofix).
- (b) **Glazed Surface or Cold Climate:** If the surface is highly glazed, or in a hill section where the climate is such that the hot asphalt used for repainting will harden before it softens the old black top surface, add 3 to 6% Socosol to hot asphalt before application.

## REPAINTING

### (Cold Process with Emulsion)

A. GENERAL DESCRIPTION: This specification provides for the repainting of bituminous surfaces with a single application of Stanvac Emulsified Asphalt blinded with stone chips and rolled. This specification is particularly suitable during wet weather. However no work should be undertaken while it is actually raining.

#### B. MATERIALS REQUIRED:

	Per 100 sq. ft.	Per 1000 sq.m
Stanvac Emulsion		
No. 3	15 to 20 lbs.	735 to 975 kg.
Stone Chips—		
$\frac{1}{4}$ " or $\frac{3}{8}$ "		
(6 or 10 mm.) size	2 to 3 cu. ft.	6 to 9 cu.m.

#### C. LABOUR REQUIRED:

Labourer days	1/3	36
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#### D. EQUIPMENT REQUIRED:

Roller (5 to 8 tons)  
Small Tools (Page 61)

#### E. ESTIMATED COST

COMPLETE:	Rs. 6	Rs. 645
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NOTE: One roller can roll 15,000 to 20,000 sq. ft. (1,400 to 1,800 sq. m.) per day.

**F. PROCEDURE:** (All pot-holes should be repaired about one week or so before commencing the work. The procedure described on pages 104, 107 or 110 is recommended for this purpose.

1. Brush the surface clean using wire brushes and bass brooms to remove all caked and foreign matter. (Page 63).
2. Dust the surface with the gunny bags to remove the remaining loose dust. (Page 63).
3. Apply emulsion by means of suitable sprayer equipment or by the usual type of pouring can. The emulsion should be used without heating. (Page 66).
4. As soon as the emulsion breaks (turns black) cover with stone chips. (Page 67). Do not brush after emulsion has started to break.
5. Roll and open to traffic after 4 to 6 hours. (Page 73).

### **ALTERNATE**

- (a) **Corrugated Surface:** If the surface is badly corrugated follow the procedure described on page 101 (Mix-in-Place with Socofix).

## **REVIVER COAT ON SMOOTH RIDING**

### **BITUMINOUS SURFACE (Cold Process)**

#### **(Low Cost Repainting With Liquid Asphalt No. 2)**

A. **GENERAL DESCRIPTION:** This specification provides for repainting a bituminous surface wherein the bitumen is dry and hungry but where the structure is still sound. It consists of an application of Liquid Asphalt No. 2 applied cold and blinded with locally available sand. No rolling is required.

B. **MATERIALS REQUIRED:**

	Per 100 sq. ft.	Per 1000 sq.m
Liquid Asphalt No. 2	8 to 12 lbs.	390 to 585 kg.
Local Sand . . .	2 cu. ft.	6 cu.m.

C. **LABOUR REQUIRED:**

Labourer days	1/5	22
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D. **EQUIPMENT REQUIRED:**

Small Tools (Page 61)  
No Roller—No Boiler

E. **ESTIMATED COST**

COMPLETE:	Rs.2½	Rs.296
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F. **PROCEDURE:** (All pot-holes should be repaired a week or so before commencing the work. The procedure described on page 104, 107 or 110 is recommended for this purpose.)

1. Brush the surface clean. (Page 63).
2. Apply Liquid Asphalt No. 2 by means of sprayer or "Kerosene tin distributors". [(See page 214 for diagram and instructions for use). The perforations should be made according to Note B(1).] Liquid Asphalt No. 2 should be used without heating.
3. Brush Liquid Asphalt No. 2 to uniform coverage with bass brooms. (Page 65).
4. Blind with sand and open to traffic at once if necessary. Wait 1 to 4 hours before applying sand, if possible, to give the Liquid Asphalt No. 2 more time to flux with the old Asphalt. (Page 68).
5. Open to traffic as soon as sand is applied. No rolling is required.

# REVIVER COAT ON SLIGHTLY ROUGH ASPHALT SURFACE

## Cold Process

### Low Cost Repainting with Socofix

A. GENERAL DESCRIPTION: This specification provides for repainting and levelling a bituminous surface that has become somewhat corrugated or irregular, but wherein the structure is still sound. It consists of repainting with Socofix, filling the depressions with a suitable Socofix premix, and finally blinding with sand.

### B. MATERIALS REQUIRED:

	Per 100 sq. ft.	Per 1000 sq.m
Socofix	12 to 18 lbs.	585 to 880 kg.
Stone Chips and/or sand for premix (according to depth of depressions)	$\frac{1}{2}$ to 1 cu.ft.	1.5 to 3 cu.m.
Coarse sand for blinding	2 cu. ft.	6 cu.m.

### C. LABOUR REQUIRED:

Labourer days	$\frac{3}{4}$	82
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### D. EQUIPMENT REQUIRED:

Small Tools (Page 61)

No Roller

No Boiler

### E. ESTIMATED COST

COMPLETE:	Rs. 5 $\frac{3}{4}$	Rs. 620
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**F. PROCEDURE:** (All deep pot-holes should preferably be repaired a week or so before commencing the work, but shallow pot-holes can be repaired along with the repainting and levelling operation). (Page 104, 107 or 110).

1. Brush the surface clean. (Page 63).
2. Apply Socofix at 8 to 12 pounds per 100 sq. ft. by means of Sprayer or "Kerosene tin distributors." [See page 214 for diagram and instructions for use. The perforations should be made according to Note B(1).] Socofix should be applied without heating.
3. Brush Socofix to uniform coverage with bass brooms. (Page 65).
4. On the side of the road and as required, or preferably 3 to 10 days before starting the work, prepare a premix of Socofix and sand using 1 gallon Socofix per 2 cu. ft. (80 kg. per 1 cu.m.) sand. Spread this on the painted surface, but in the depression only. Use it to fill and level depressions up to  $\frac{1}{4}$ " (6 mm.) in depth.
5. Prepare a similar premix with  $\frac{1}{4}$ " or  $\frac{3}{8}$ " (6 or 10 mm.) stone chips using 10 lbs. to 3 cu. ft. (53 kg. to 1 cu.m.) chips. Use it to fill depressions up to  $\frac{1}{2}$ " (12 mm.) in depth. Use larger chips premixed with Socofix at the same rate for levelling deeper depressions.
6. Level and compact premix with a rammer.
7. After painting and levelling the surface as described above blind with 2 cu.ft. sand per 100 sq.ft. (0.6 cu.m. per 100 sq.m.).
8. Open to traffic as soon as sand is applied. No rolling is required.

# REPAINTING A CORRUGATED BITUMINOUS SURFACE

(Cold Process)

(Mix-in-Place With Socofix)

A. GENERAL DESCRIPTION: This specification provides for the resurfacing and levelling of a corrugated bituminous surface by an application of Socofix, blinded with stone chips, and rolled after mixing the materials together and levelling the surface by means of a drag broom. (Page 213).

B. MATERIALS REQUIRED:

	Per 100 sq.ft.	Per 1000 sq.m
Socofix	25 to 30 lbs.	1220 to 1470 kg.
Stone Chips—		
$\frac{1}{2}$ " (12mm.) size	4 to 5 cu. ft.	12 to 15.25 cu.m.
$\frac{1}{4}$ " (6mm.) size	2 cu. ft.	6 cu.m.

C. LABOUR REQUIRED:

Labourer days	2/3	72
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D. EQUIPMENT REQUIRED:

Small Tools (Page 61)  
Roller (5 to 8 tons)  
No Boiler

E. ESTIMATED COST

COMPLETE:	Rs. 13	Rs. 1390
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NOTE: One roller can roll 10,000 sq. ft. (930 sq. m.) per day but a greater daily output is difficult to control and apt to produce inferior work.

**F. PROCEDURE:** (All deep pot-holes should be repaired one week or so before work is commenced. Use procedure described on page 107).

1. Brush the surface clean. (Page 63).
2. Apply Socofix at 10 to 15 pounds per 100 sq. ft. (5 to 7 kg. per 10 sq.m.) by means of Sprayer or "Kerosene tin distributors." [See page 214 for diagram and instructions for use. The perforations should be made according to Note B(1).] Socofix should be applied cold without heating.
3. Brush Socofix to uniform coverage with bass brooms. (Page 65).
4. Spread the  $\frac{1}{2}$ " (12mm.) stone chips. (Page 68).
5. Apply Socofix at 15 pounds per 100 sq. ft. (7 kg. per 10 sq.m.) by means of Sprayer or Kerosene tin distributors."
6. Drag the surface, using labourers or a lorry to tow the drag broom. (See page 213 for diagram of drag broom). Three to six trips are sufficient.
7. Drag and roll simultaneously by using the roller to tow the drag broom. During this operation touch up the surface with a very light application of fresh chips and Socofix wherever the drag is not bearing. Dampen the rolls with water to prevent them from picking up.
8. Roll without the drag broom and simultaneously sprinkle on the bare patches  $\frac{1}{4}$ " chips (6 mm.) premixed with Socofix (3 cu. ft. chips to 1 gallon Socofix or 53 kg. to 1 cu.m.)
9. Spread 2 cu. ft.  $\frac{1}{4}$ " chips per 100 sq. ft. (0.6 cu.m. per 100 sq.m.) chips and continue rolling and dragging until the surface closes up.
10. Open to traffic on following day.



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## **REPAIRS TO POTHOLES**

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- **HOT PROCESS**

- Dry Weather Conditions

- ● **COLD PROCESS**

- Dry Weather Conditions

- Monsoon Conditions

## REPAIRS TO POT-HOLES – (Hot Process)

A. **GENERAL DESCRIPTION:** This specification provides for patching pot-holes and depressions with a premix of mineral aggregate and hot cutback asphalt under dry weather conditions.

### B. MATERIALS REQUIRED:

1. **Asphalt:** Stanvac Paving Asphalt 30/40 or 80/100 cutback with Socosol at site (see page 69) and premixed with the aggregate at the rate of 3 lbs. per c.ft. of  $1\frac{1}{2}$ " to 1" size (48kg. per cu.m. of 4 to 2.5 cm. size) and  $3\frac{3}{4}$  lbs. per cu.ft. of  $\frac{3}{4}$ " to  $\frac{1}{4}$ " size (60 kg. per cu.m. of 2cm. to 6 mm. size). The rate of binder specified above is the combined weight of Stanvac Paving Asphalt & Socosol.

2. **Aggregates:**  $1\frac{1}{2}$ " to 1" (4 to 2.5 cm.) for depths greater than  $1\frac{1}{2}$ " (4 cm.) – laid in two courses. and  $\frac{3}{4}$ " to  $\frac{1}{4}$ " (2 cm. to 6 mm.) for depths upto  $1\frac{1}{2}$ " (4 cm.) and less.

Sand for blinding.

Requirements per 200 cu.ft. or 10 cu.m. of patching mixture.

Size	Aggregates Quantity	Total quantity of Asphalt 30/40 or 80/100 and Socosol
$1\frac{1}{2}$ " to 1" (4 to 2.5 cm.)	100 cu. ft. (5 cu. m.)	$282+18=300$ lb. ( $226+14=240$ kg.)
$\frac{3}{4}$ " to $\frac{1}{4}$ " (2 cm. to 6mm.)	100 cu. ft. (5 cu. m.)	$353+22=375$ lb. ( $282+18=300$ kg.)

### C. LABOUR:

For preparing & laying 100 cu.ft.  
(2.83 cu.m.) of premix complete 18 labourer days

### D. EQUIPMENT:

Roller or tamper.

Hand operated drum or power driven mixer  
(Page 71).

Boiler or half-cut drums for heating asphalt.

Small tools (Page 61).

### E. ESTIMATED COST COMPLETE:

Rs. 150 per 100 cu.ft. (2.83 cu.m.) when using  $1\frac{1}{2}$ " to 1" (4 to 2.5 cm.) metal. Rs. 180 per 100 cu.ft. (2.83 cu.m.) when using  $\frac{3}{4}$ " to  $\frac{1}{4}$ " (2 cm. to 6 mm.) metal.

NOTE: One roller can roll 3000 sq. ft. (280 sq. m.) of patched area in one day. One hand operated drum mixer can premix 200 cu.ft. (5.66 cu.m.) of metal per day. Each boiler can heat  $1\frac{1}{2}$  to 2 charges daily.

### F. PROCEDURE:

1. **Preparation of Premix:** (Batches should be proportioned according to the capacity of the mixers)

- (a) Heat Stanvac Paving Asphalt 30/40 or 80/100 to a temperature of 325° to 350°F (163 to 177°C). Draw off the correct batch quantity of heated asphalt from the boiler into suitable containers and add (while stirring) the proportionate quantity of Socosol. Generally 1 oz. of Socosol is used per pound of molten asphalt (about 6%) but the proportion can be varied to suit the climatic conditions. (Page 69).

- (b) Place the correct batch quantity of aggregate in the mixer and pour over it its proportionate quantity of cutback asphalt prepared as described in F (1) (a) above.
- (c) Continue mixing until the aggregate is uniformly coated.

## 2. Laying:

- (a) Cut square shoulders on the pot-hole and remove all loose and defective material. Clean the sides and bottom thoroughly.
- (b) Spot prime the bottom and paint the edges of the patch thinly with hot cutback asphalt prepared as described in F(1) (a) above.
- (c) Fill the pot-hole with prepared premix. Depths greater than  $1\frac{1}{2}$ " (4 cm.) should be laid in two courses, the larger size aggregates to be laid at the bottom and finished off with the smaller size aggregates at the top. In case of pot-holes less than  $1\frac{1}{2}$ " (4 cm.) in depth use only the smaller size aggregates.
- (d) Compact thoroughly either by rolling or by means of tamper, taking care to leave the finished surface a little proud say  $\frac{1}{8}$ " to  $\frac{1}{4}$ " (3 to 6 mm.) to take care of final compaction under traffic. (Dampen the tamper or roller wheels to prevent picking up).
- (e) Open to traffic after dusting the surface with sand and working it into the voids. (One cu.ft. of sand per 100 sq.ft. or 0.3 cu.m. per 100 sq.m.)

# REPAIRS TO POT-HOLES WITH SOCOFIX

## (Cold Process)

A. **GENERAL DESCRIPTION:** This specification provides for patching pot-holes and depressions with a premix of mineral aggregate and Socofix. Under dry weather conditions use Socofix and during monsoons use Socofix with water repellent additive or emulsion.

### B. MATERIALS REQUIRED:

1. **Asphalt:** Socofix to be premixed with aggregate at the rate of 3 lbs. per cu. ft. of  $1\frac{1}{2}$  to 1" size (48 kg. per cu.m. of 4 to 2.5 cm. size) and  $3\frac{3}{4}$  lbs. per cu.ft. of  $\frac{3}{4}$ " to  $\frac{1}{4}$ " size (60 kg. per cu.m. of 2 cm. to 6 mm. size).

2. **Aggregate:**  $1\frac{1}{2}$ " to 1" (4 to 2.5 cm.) for depths greater than  $1\frac{1}{2}$ " (4 cm.)—Laid in two courses. For depths upto  $1\frac{1}{2}$ " (4 cm.) and less —  $\frac{3}{4}$ " to  $\frac{1}{4}$ " (2 cm. to 6 mm.).

Sand for Blinding:

Requirements per 200 cu.ft. or 10 cu.m. of patching mixture.

Size	Aggregates Quantity	Total quantity of Socofix
$1\frac{1}{2}$ " to 1"	100 cu.ft.	300 lbs.
(4 to 2.5 cm.)	(5 cu.m.)	(240 kg.)
$\frac{3}{4}$ " to $\frac{1}{4}$ "	100 cu.ft.	375 lbs.
(2 cm. to 6mm.)	(5 cu.m.)	(300 kg.)

### C. LABOUR:

For preparing & laying

100 cu.ft. (2.83 cu.m.) of premix complete

15 labourer days

### D. EQUIPMENT:

Hand operated drum or power driven mixer

(Page 70).

Roller or Tamper.

Small tools (Page 61).

### E. ESTIMATED COST COMPLETE:

(1) Rs. 155 per 100 cu.ft. (2.83 cu.m.) when using  
1½" to 1" (4 to 2.5 cm.) metal.

(2) Rs. 185 per 100 cu.ft. (2.83 cu.m.) when using  
¾" to ¼" (2 cm. to 6 mm.) metal.

NOTE: One roller can roll 3,000 sq. ft. (280 sq. m.) of patched area in one day. One hand operated drum mixer can premix 200 cu. ft. (5.66 cu. m.) of metal per day. For small works mixing may be carried out on a clean platform with shovels.

### F. PROCEDURE:

#### 1. Preparation and Storage of Premix:

(a) Prepare the premix at least 3 days in advance of use. When using Socofix stone should be dry.

Mix ingredients together with shovels or in a mixer (Page 70).

(b) Stock-pile and cover with a tarpaulin, if necessary to keep it more than 2 to 3 weeks (Page 66).

- NOTE: 1. If quicker setting is desired coat aggregate with about 1 lb. of slaked lime per 1 cu. ft. (16 kg. per cu.m.) of metal before premixing.
2. If stone available is soft and friable prepare Asphaltic Concrete premix (stone, sand and Socofix) see page (134)

## **2. Laying:**

- (a) Cut square shoulders on the pot-holes and remove all loose and defective material. Clean the sides and bottom thoroughly.
- (b) Paint the edges thinly with Socofix and spot prime the bottom of the patch.
- (c) Fill the pot-holes with the prepared premix. Depths greater than  $1\frac{1}{2}$ " (4 cm.) should be laid in two courses, the larger sized aggregates to be laid at the bottom and finished off with the smaller sized aggregates at the top. In case of pot-holes less than  $1\frac{1}{2}$ " (4 cm.) in depth use only the smaller sized aggregates.
- (d) Compact thoroughly either by rolling or by means of tampers, taking care to leave the finished surface a little proud say  $\frac{1}{8}$ " to  $\frac{1}{4}$ " (3 to 6 mm.) to take care of final compaction under traffic. (Dampen the tampers or roller wheels to prevent picking up).
- (e) Open to traffic after brushing dry sand over the patch and working it into the surface voids. (One cu.ft. of sand per 100 sq.ft. or 0.3 cu.m. per 100 sq.m.)

# REPAIRS TO POT-HOLES WITH EMULSION

## (Cold Process)

A. GENERAL DESCRIPTION: This specification provides for patching pot-holes and depressions with a premix of mineral aggregates and Stanvac Emulsion No. 6, particularly under monsoon conditions. However no work should be undertaken while it is actually raining.

### B. MATERIALS REQUIRED:

1. **Asphalt:** Stanvac Emulsion No. 6 to be used to premix aggregates at the rate of 4 to 5 lbs. per cu.ft. of  $1\frac{1}{2}$ " to 1" size (65 to 80 kg. per cu.m. of 4 to 2.5 cm. size) and 5.5 to 6.5 lbs. per cu.ft. of  $\frac{3}{4}$ " to  $\frac{1}{4}$ " size (90 to 105 kg. per cu.m. of 2cm. to 6 mm. size).

2. **Aggregates:**  $1\frac{1}{2}$ " to 1" (4 to 2.5 cm.) for depths greater than  $1\frac{1}{2}$ " (4 cm.) – Laid in two courses. and  $\frac{3}{4}$ " to  $\frac{1}{4}$ " (2 cm. to 6 mm.) for depths upto  $1\frac{1}{2}$ " (4 cm.) and less.

Sand for Blinding.

Requirements per 200 cu.ft. or 10 cu.m. of  
Patching Mixture.

Size	Aggregates Quantity.	Total Quantity of Emulsion No. 6
$1\frac{1}{2}$ " to 1"	100 cu.ft.	500 lbs.
(4 to 2.5 cm.)	(5 cu.m.)	(400 kg.)
$\frac{3}{4}$ " to $\frac{1}{4}$ "	100 cu.ft.	650 lbs.
(2 cm. to 6 mm.)	(5 cu.m.)	(525 kg.)

### C. LABOUR:

For preparing and laying.

100 cu.ft. (2.83 cu.m.) complete      15 labour days

### D. EQUIPMENT:

Roller or Tamper.

Small tools (Page 61).

### E. ESTIMATED COST COMPLETE:

1. Rs. 152 per 100 cu.ft. (2.83 cu.m.) when using  
1½" to 1" (4 to 2.5 cm.) metal.

2. Rs. 186 per 100 cu.ft. (2.83 cu.m.) when using  
¾" to ¼" (2 cm. to 6 mm.) metal.

NOTE: One roller can roll 3,000 sq. ft. (280 sq. m.) of  
patched area in one day.

### F. PROCEDURE:

1. Cut square shoulders on the edges of the pot-holes and remove all loose and defective material. Clean the sides and bottom thoroughly.
2. Paint the edges thinly with Stanvac Emulsion No. 6. Spot prime the bottom of the patch in case of patches over 1½" (4 cm.) and paint thinly the shallower patches.
3. Fill one bucket with Stanvac Emulsion No. 6. Perforate a smaller bucket and fill it with stone metal or stone chips according to the depth of the pot-hole to be repaired. Dip the perforated bucket containing the aggregate into the bucket containing Stanvac Emulsion No. 6 and allow the emulsion to percolate through the aggregate. Lift the bucket containing aggregate from the bucket containing emulsion and allow the excess emulsion to drain off. Be sure all excess drains off.

4. Fill the pot-hole with the prepared premix. Depths greater than  $1\frac{1}{2}$ " (4 cm.) should be laid in two courses, the larger size aggregate to be laid at the bottom and finished off with the smaller size aggregate at the top. In the case of pot-holes less than  $1\frac{1}{2}$ " (4 cm.) in depth use only the smaller size aggregate.
5. Compact thoroughly either by rolling or by means of tampers taking care to leave the finished surface a little proud say  $\frac{1}{8}$ " to  $\frac{1}{4}$ " (3 to 6 mm.) to take care of final compaction under traffic. (Dampen the tamper or roller wheels to prevent picking up).
6. Brush dry sand over the repaired pot-hole and work into surface voids.
7. Paint with Stanvac Emulsion No. 6 and carry this painting a few inches beyond the edge of the pot-hole.
8. Blind with sand and open to traffic. (1 cu.ft. of sand per 100 sq.ft. or 1 cu.m. per 333 sq.m.).

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## **PENETRATION MACADAM**

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- **HOT PROCESS**

- Full Grout**

- Semi Grout**

- ● **COLD PROCESS**

- Semi Grout with Emulsion**

# STANVAC PENETRATION MACADAM

## (FULL GROUT)

**A. GENERAL DESCRIPTION:** This specification provides for the construction of a Stanvac Penetration Macadam surface course composed of mineral aggregate and Stanvac Paving Asphalt 30/40 or 60/70 laid over a suitable base to a thickness of 2" to 2½" (5 to 6 cm.) and seal coated with Stanvac Paving Asphalt 80/100. Asphalt is used hot and aggregate cold.

### B. MATERIALS REQUIRED:

	Per 100 sq.ft.		Per 1,000 sq.m.	
	2"	2½"	5 cm.	6 cm.
Stanvac Paving Asphalt 60/70 or 30/40—for Grout	112 lbs.	140 lbs.	5470 kg.	6835 kg.
Stanvac Paving Asphalt 80/100 for Seal Coat	30 to 40 lbs.	30 to 40 lbs.	1465 to 1950 kg.	1565 to 1950 kg.
Coarse Aggregate 1" to 1½" Metal (2.5 to 4 cms.)	17 cu.ft.	—	52 cu.m	—
1½" to 2" (4 to 5 cm.) Metal	—	22 cu.ft.	—	67 cu.m
Intermediate Aggregate ½" (12 mm.) Stone Chips	5 cu.ft.	5 cu.ft.	15 cu.m	15 cu.m
Fine Aggregate for Seal Coat ¼" (6 mm.) Stone Chips	4 cu.ft.	4 cu.ft.	12 cu.m	12 cu.m

### C. LABOUR REQUIRED:

Labourer days	1½	1½	162	188
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## D. EQUIPMENT REQUIRED:

Small Tools (page 61)

Boiler

Roller

## E. ESTIMATED COST COMPLETE:

Per 100 sq. ft.		Per 1,000 sq.m.	
2"	2½"	5 cm.	6 cm.
Rs. 47/00	Rs. 56/00	Rs. 5,060	Rs. 6,025

**NOTE: ROLLER:** One roller can roll 6,000 to 7,000 sq. ft. (550 to 650 sq.m.) per day.

**BOILER:** One boiler can heat 1½ to 2 charges daily.

## F. PROCEDURE:

All pot-holes and depressions in the base should be made good before commencing the work. The material of which the structure is built is recommended for this purpose:

1. Brush the base clean (page 62).
2. Spread the coarse aggregate in a uniform loose layer.
3. Roll to lock the stone-metal (page 73).
4. Check for grade and camber and add or remove coarse aggregate as required.
5. Apply Stanvac Paving Asphalt 30/40 or 60/70 at a temperature of 350 to 375°F (177 to 190°C) at the rate specified. The stone metal should be absolutely dry when the asphalt is applied.
6. Spread Intermediate aggregate at once (page 68).
7. Roll with a power roller. Broom during the rolling operations (page 73).

## **SEAL COAT.**

- 8. Immediately after rolling the Intermediate aggregate sweep the surface clean of all loose foreign material.**
- 9. Apply Stanvac Paving Asphalt 80/100 at a temperature of 325 to 350°F. (163 to 177°C) at the rate specified (page 64).**
- 10. Spread fine aggregate while the asphalt is still hot.**
- 11. Roll hard and broom during the rolling operations (page 73).**
- 12. Open to traffic.**

## SEMI-GROUT (Hot Process)

**A. GENERAL DESCRIPTION:** This specification provides for the treatment of old water-bound roads which have deteriorated to the extent where scarifying is necessary and where immediate treatment with asphalt after remetalling is desired.

### B. MATERIALS REQUIRED:

<b>1. Asphalt:</b>	Per 100 sq. ft.	Per 1000 sq.m
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Stanvac Paving Asphalt 30/40 or 60/70 or 80/100 for grout	56 lbs.	2750 kg.
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Stanvac Paving Asphalt 80/100 for seal coat	37 lbs.	1810 kg.
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#### 2. Aggregates:

Coarse Aggregate 1½" to 2" (4 to 5 cm.) Stone Metal	17 cu.ft.	51.8 cu.m.
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Intermediate Aggregate ¾" (12 mm.) Stone Metal	6 cu.ft.	18.3 cu.m.
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Fine Aggregate ¾" (6 mm.) Stone Metal	4 cu.ft.	12 cu.m.
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### C. LABOUR REQUIRED:

Labourer days	2	215
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#### D. EQUIPMENT REQUIRED:

Roller

Boiler

Small Tools (Page 61)

#### E. ESTIMATED COST COMPLETE:

Rs. 40 per 100 sq. ft.    Rs. 4310 per 1000 sq. m.

NOTE: One roller can roll 6000 to 7000 sq. ft. (560 to 650 sq. m.) per day. Each boiler can heat  $1\frac{1}{2}$  to 2 charges daily.

#### F. PROCEDURE:

1. Scarify the existing surface  $1\frac{1}{2}$ " to 3" (4 to 8 cm.) in depth and about 1 ft. (30 cm.) beyond the width to be treated. Separate metal over  $\frac{3}{4}$ " (2 cm.) size and remove to the side of the road.
2. Spread the fine material excavated from the road mixed with additional fine material of the type usually adopted locally as blinding material for water-bound roads to provide roughly  $\frac{1}{4}$ " thickness per inch thickness of metal (6 mm. per 2.5 cm. thickness).
3. Shape the road to proper grade and camber and roll lightly.
4. Spread old metal (obtained as per F(1) above) uniformly upto 1 ft. (30 cm.) beyond the width to be treated.
5. Spread new coarse aggregate at the specified rate over the old metal.
6. Roll dry to lock metal particles.
7. Wet roll until hoggin creams up from the bottom. Water should be added slowly to prevent creaming before the metal is properly consolidated.

Continue rolling until surface becomes firm and the hoggin creams upto  $\frac{1}{2}$ " to  $\frac{3}{4}$ " (12 mm. to 2cm.) below the surface. Grout with a slurry of hoggin areas where it does not cream up to the above level.

8. Allow 48 hours for the road to dry.
9. Lightly brush the surface to remove foreign matter taking care not to disturb consolidated metal. Places where hoggin has creamed up flush with the surface should be wire-brushed to open up the interstices to  $\frac{1}{2}$ " to  $\frac{3}{4}$ " (12 mm. to 2 cm.).
10. Apply Stanvac Paving Asphalt 30/40 or 60/70 or 80/100 heated to 350°F (177°C) at the rate specified for grout by means of suitable spraying equipment.
11. Immediately after asphalt application and while it is still hot spread the intermediate aggregate uniformly over the surface at the rate specified and roll until the chips are firmly bonded to the surface. Broom the surface while rolling.

### SEAL COAT

12. Sweep the surface clean of all loose and foreign material.
13. Apply Stanvac Paving Asphalt 80/100 heated to 350°F (177°C) at the rate specified for seal coat.
14. Spread immediately, while the asphalt is still hot, the specified quantity of Fine Aggregate.
15. Roll and broom the surface till the chips are firmly bonded to the surface.
16. Treat and maintain the 1 ft. (30 cm.) wide sides as water-bound surface.

## SEMI-GROUT (Cold Process)

A. GENERAL DESCRIPTION: This specification provides for the treatment of old water-bound roads which have deteriorated to the extent where scarifying is necessary and where immediate treatment with asphalt after remetalling is desired.

### B. MATERIALS REQUIRED:

	Per 100 sq. ft.	Per 1000 sq.m.
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#### 1. Asphalt:

Stanvac Emulsion No. 3 or No. 6 for grout	56 lbs.	2750 kg.
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Stanvac Emulsion No. 3 or No. 6 for Seal Coat	37 lbs.	1810 kg.
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#### 2. Aggregates:

Coarse Aggregate 1½" to 2" (4 to 5 cm.) Stone Metal	17 cu.ft.	51.8 cu.m.
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Intermediate Aggregate ½" (12 mm.) Stone Metal	6 cu.ft.	18.3 cu.m.
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Fine Aggregate ¾" (6 mm.) Stone Metal	4 cu.ft.	12 cu.m.
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### C. LABOUR REQUIRED:

Labourer days	2	215
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### D. EQUIPMENT REQUIRED:

Roller  
Small Tools (Page 61)

## **E. ESTIMATED COST COMPLETE:**

**Rs. 39½ per 100 sq.ft.      Rs. 4250 per 1000 sq.m.**

**NOTE:** One roller can roll 6000 to 7000 sq.ft (560 to 650 sq.m.) per day.

## **F. PROCEDURE:**

1. Scarify the existing surface 1½" to 3" (4 to 8 cm.) in depth and about 1 ft. (30 cm.) beyond the width to be treated. Separate metal over ¾" (2 cm.) size and remove to the side of the road.
2. Spread the fine material excavated from the road mixed with additional fine material of the type usually adopted locally as blinding material for waterbound roads to provide roughly ¼" thickness per inch thickness of metal (6 mm. per 2.5 cm. thickness).
3. Shape the road to proper grade and camber and roll lightly.
4. Spread old metal (obtained as per F(1) above) uniformly upto 1 ft. (30 cm.) beyond the width to be treated.
5. Spread new Coarse Aggregate at the specified rate over the old metal.
6. Roll dry to lock metal particles.
7. Wet roll until hoggin creams up from the bottom. Water should be added slowly to prevent creaming before the metal is properly consolidated. Continue rolling until surface becomes firm and the hoggin creams up to ½" to ¾" (12 mm. to 2 cm.) below the surface. Grout with a slurry of hoggin areas where it does not cream up to the above level.
8. Lightly brush the surface to remove foreign matter taking care not to disturb the consolidated metal.

Places, where hoggin has creamed up flush with the surface should be wire-brushed to open up the interstices to  $\frac{1}{4}$ " to  $\frac{3}{4}$ " (12 mm. to 2 cm.).

9. When the surface is still damp but not too wet apply Stanvac Emulsion No. 3 or No. 6 longitudinally at the rate specified by means of suitable spraying equipment.
10. Spread the Intermediate Aggregate uniformly over the surface at the specified rate as soon as the emulsion begins to break.
11. Roll immediately until the chips are firmly bonded to the surface. Broom the surface while rolling.

### **SEAL COAT.**

12. Sweep the surface clean of all loose and foreign material.
13. Apply Stanvac Emulsion No. 3 or No. 6 at the specified rate.
14. As soon as the emulsion breaks, spread the Fine Aggregate uniformly at the rate specified.
15. Roll and broom surface till the chips are firmly bonded to the surface.
16. Treat and maintain 1 ft. (30 cm.) wide sides as water-bound surface.

**NOTE:** Because of its higher Asphalt content use of Emulsion No. 6 will result in heavier applications than when Emulsion No. 3 is used.

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## THIN PREMIXES

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- HOT PROCESS

- $\frac{3}{4}$ " and 1" Premixed Macadam
  - Sheet Macadam or
  - Premixed Seal Coated Macadam
  - 1" Asphaltic Concrete

- ● COLD PROCESS

- $\frac{3}{4}$ " and 1" Premixed Macadam
  - 1" Asphaltic Concrete

# STANVAC PREMIXED ASPHALT MACADAM.

(Hot Process)

1" (2.5 cms.) and  $\frac{3}{4}$ " (2 cms.)

## Premixed Chipping Carpet

A. GENERAL DESCRIPTION: This specification provides for a STANVAC PREMIXED ASPHALT MACADAM surface course which consists of a mixture of graded broken metal and cutback asphalt binder (Stanvac Paving Asphalt 80/100 mixed with the solvent Socosol) laid in one course over a suitable base to a thickness of 1" or  $\frac{3}{4}$ " (2.5 cm. to 2 cm.). The stone is used without heating. The asphalt is heated to a temperature of 325°F to 350°F (163° to 177°C).

## B. MATERIALS REQUIRED:

	Per 100 sq. ft.		Per 1000 sq. m.	
	1"	$\frac{3}{4}$ "	2.5 cm.	2 cm.
Stone chips $\frac{3}{4}$ " (2 cm.)	6 cu.ft.	—	18.3 cu. m.	—
Stone Chips $\frac{1}{2}$ " (12 mm.)	—	6	—	18.3 cu.m.
Stone Chips $\frac{3}{8}$ " (10 mm.)	4	—	12 cu.m	—
Stone Chips $\frac{1}{4}$ " (6 mm.)	2	3	6 cu.m.	9 cu.m.
Stanvac Paving Asphalt 80/100	40 lbs.	32 lbs.	1953 kg.	1563 kg.
Socosol	2.4 lbs.	1.9 lbs.	117 kg.	93 kg.

## C. LABOUR REQUIRED:

Labourer days	1	4/5	107	86
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## D. EQUIPMENT REQUIRED:

Roller.

Boiler.

Mixer – Power driven or hand operated.

Small Tools (Page 61)

## E. ESTIMATED COST COMPLETE:

per 100 sq. ft.		per 1000 sq.m.	
1"	$\frac{3}{4}$ "	2.5 cms.	2 cms.
Rs. 20	Rs. 15	Rs. 2,153	Rs. 1,615

(Excluding Tack Coat)

**NOTE: LABOUR:** The labour estimates are based on the assumption that a power mixer will be used. If mixing is by hand or in drum mixers the labour requirements should be increased by about 50%.

**ROLLER:** One roller can roll 10,000 to 12,000 sq. ft. (930 to 1115 sq. m.) per day.

**BOILER:** One boiler can heat  $1\frac{1}{2}$  to 2 charges daily.

**TACK COAT:** The above estimates of materials and labour do not include the tack coat. If the premix is being laid over a black top surface provide for 10 to 15 lbs. per sq. ft. (490 to 735 kg. per 1000 sq. m.) On a water-bound surface provide for 15 to 20 lbs. per 100 sq.ft. (735 to 975 kg. per 1000 sq. m.) **TACK COAT** may be given with the same cut back binder used for premix.

## F. PROCEDURE:

1. **Preparation of Premix:** (Batches should be proportioned according to the capacity of the mixer).

- (a) The correct batch quantity of Stanvac Paving Asphalt 80/100 heated to a temperature of 325°F to 350°F (163° to 177°C) should be drawn off from the boiler into a suitable container and the proportionate quantity of Socosol added thereto while stirring the asphalt. Usually 1 oz. of Socosol is used per pound of asphalt (about 6%) but the proportions can be varied to suit climatic conditions (Page 69).

- (b) Place the correct batch quantity of aggregate in the mixer and pour over it its proportionate quantity of cutback asphalt prepared as described under F(1) (a) above.
- (c) Continue mixing until the aggregate is uniformly coated.

## 2. CONSTRUCTION:

(All pot-holes and depressions in the base should be made good before the work is started. If the premix is laid over a black top surface the procedure described on page 104 is recommended for patching all potholes. If the premix is laid over a structure not previously surfaced the material of which the structure is originally built can be used for patching pot-holes).

- (a) Brush the base clean (Page 62).
- (b) If the surface has been black topped already apply tack coat at 10 to 15 lbs. per 100 sq. ft. (490 to 735 kg. per 1000 sq.m.). On untreated surface apply tack coat at 15 to 20 lbs. per 100 sq. ft. (735 to 975 kg. per 1000 sq.m.). Tack coat may be applied with the same cutback binder used for the premix.
- (c) Paint the edges of all kerbs, manholes etc. with binder used in the premix (Page 71).
- (d) Spread the premix at the rate specified and in a uniform layer (Page 71).
- (e) Roll with a power roller. Check for grade and camber during rolling and add or remove premix as required (Page 73).
- (f) Keep closed to traffic for 24 hours if possible.

### **3. SEAL COAT:**

A seal coat is not always necessary but it is desirable as it will add to the life of the structure and is therefore recommended — particularly in localities where the rainfall is heavy. It may be applied immediately following construction or at such later date as may be specified by the Engineer-in-charge. It should be applied according to the specification for Repainting contained on page 93.

# STANVAC SHEET MACADAM

(Hot or Cold Process)

A. GENERAL DESCRIPTION: This specification provides for the construction of an asphalt wearing surface consisting of a Stanvac Premixed Asphalt Macadam course laid to the specification on page 124 or 133 and followed immediately with a premixed sand Seal Coat.

## B. MATERIALS REQUIRED:

	Per 100 sq. ft.	Per 1000 sq.m.
Asphalt—Socofix	10 to 15 lbs.	490 to 735 kg.

Alternatively:

Stanvac Paving

Asphalt 80/100	10 to 15 lbs.	490 to 735 kg.
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Socosol	10 to 15 ozs.	30 to 45 kg.
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Sand	2 cu.ft.	6 cu.m.
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Plus requirements for specification on pages 124 or 133.

## C. LABOUR REQUIRED:

Labourer days	2/5	43
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Plus requirements for specification on pages 124 or 133.

## D. EQUIPMENT REQUIRED:

Small Tools (page 61 )

Plus requirements for specification on pages 124 or 133.

## E. ESTIMATED COST COMPLETE:

Rs. 3/50	Rs. 377/00
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Plus requirements for specification on pages 124 or 133.

## **F. PROCEDURE:**

- 1. Construct a Premixed Asphalt Macadam surface course to the thickness desired according to the specification on pages 124 or 133.**
- 2. Immediately after completing step F (2) (e) on page 126 or F(2) (e) on page 135 apply a premixed sand seal coat consisting of a good quality coarse clean sand premixed with Socofix at 5 to 7 lbs. per cu.ft. (80 to 110 kg. per cu.m.) It should be applied at the rate of 2 cu.ft. per 100 sq.ft. (6 cu.m. per 1000 sq.m.) and should be rubbed into the surface voids.**

### **ALTERNATE:**

**Stanvac Paving Asphalt 80/100 and Socosol may be used in lieu of Socofix if a power driven pug-mill type mixer is available to ensure proper mixing. In this case the asphalt is used hot while the sand can be used cold.**

# STANVAC ASPHALTIC CONCRETE

## (Hot Process)

1" (2.5 cm.) Dense Graded Premixed Carpet.

- A. GENERAL DESCRIPTION: This specification provides for the construction of a Stanvac Asphaltic Concrete surface course which consists of a mixture of coarse and fine mineral aggregate and cutback asphalt binder (Stanvac Paving Asphalt 80/100 mixed with the solvent Socosol) laid in one course over a suitable base to a depth of 1" (2.5cm.). The aggregate is used without heating. The asphalt is used at a temperature of 325°F to 350°F (163 to 177°C).

### B. MATERIALS REQUIRED:

	Per 100 sq. ft.	Per 1000 sq.m
Stone chips $\frac{3}{4}$ " (2 cm.)	5 cu.ft.	15.25 cu.m.
Stone chips $\frac{3}{8}$ " (10 mm.)	3 cu.ft.	9 cu.m.
Sand	4 cu.ft.	12 cu.m.
Stanvac Paving Asphalt 80/100	50 lbs.	2442 kg.
Socosol	3 lbs.	147 kg.

### C. LABOUR REQUIRED:

Labourer days	1	107
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### D. EQUIPMENT:

Roller

Boiler

Mixer-Power driven Pug Mill type, (Page 71)

Small tools (page. 61)

## E. ESTIMATED COST COMPLETE:

(excluding Tack coat)      Rs. 19.50      Rs. 2100

**NOTE: LABOUR:** The labour estimate is based on the assumption that a power mixed will be used. Mixing by hand or in drum mixers is not recommended for this type of premix (page 71).

**ROLLER:** One roller can roll 10,000 to 12,000 sq. ft. (930 to 1115 sq. m.) per day.

**BOILER:** One boiler can heat  $1\frac{1}{2}$  to 2 charges daily.

**TACK COAT:** The above estimates of material and labour do not include the tack coat. If the premix is being laid over a black top surface provide for 10 to 15 lbs. per 100 sq. ft. (490 to 735 kg. per 1000 sq. m.). On a waterbound surface provide for 15 to 20 lbs. per 100 sq. ft. (735 to 975 kg. per 1000 sq. m.). TACK COAT may be given with the same cutback binder used for the premix.

## F. PROCEDURE:

**Preparation of Premix:** (Batches should be proportioned in accordance with the capacity of the mixer).

- (a) The correct batch quantity of Stanvac Paving Asphalt 80/100 heated to a temperature of 325 to 350°F (163 to 177°C) should be drawn off into a suitable container and the proportionate quantity of Spcosol added thereto while stirring the asphalt. Generally one oz. of Socosol is used per pound of asphalt (about 6%) but the proportions can be varied to suit climatic conditions (page 69).
- (b) Place the stone in the mixer and pour on to it approximately  $\frac{2}{3}$  of the batch quantity of cutback asphalt prepared as described above. Mix until the stone is uniformly coated.
- (c) Add sand and continue mixing until the sand is uniformly distributed throughout the mix.
- (d) Add the remaining asphalt and continue mixing until it is uniformly mixed in.

## **2. CONSTRUCTION:**

All pot-holes and depression in the base should be made good before work commences. If the premix is being laid over a black top surface the procedure described on page 104 is recommended for patching all pot-holes. If the premix is being laid over a structure not previously surfaced the material of which the structure is built can be used for patching pot-holes.

- (a) Brush the base clean (page 62).
- (b) If the surface has been previously black topped apply tack coat at 10 to 15 lbs. per 100 sq. ft. (490 to 735 kg. per 1000 sq.m.) On untreated surface apply tack coat at 15 to 20 lbs. per 100 sq. ft. (735 to 975 kg. per 1000 sq.m.). Tack coat may be applied with the same cutback binder used for the premix.
- (c) Paint the edges of all kerbs, manholes etc. with the binder used in the premix (page 71).
- (d) Spread premix in a uniform layer at the rate specified (page 71).
- (e) Roll with a power roller. Check for grade and camber during rolling and add or remove premix as required (page 73).
- (f) Keep closed to traffic for 24 hours if possible.

# STANVAC PREMIXED ASPHALT MACADAM

## (Cold Process)

1" (2.5 cms.) and  $\frac{3}{4}$ " (2 cms.)

### Premixed Chipping Carpet

A. GENERAL DESCRIPTION: This specification provides for a STANVAC PREMIXED ASPHALT MACADAM surface course which consists of a mixture of graded broken metal and cold application cutback asphalt binder laid in one course over a suitable base to a thickness of 1" or  $\frac{3}{4}$ " (2.5 or 2cm.). This specification is also very suitable for small projects such as surfacing railway station platforms, estate driveways, tennis courts etc. It is also recommended for surfacing airport runways carrying moderate traffic. All materials are used without heating.

### B. MATERIALS REQUIRED:

	Per 100 sq. ft.		Per 1000 sq. m.	
	1"	$\frac{3}{4}$ "	2.5 cm.	2 cm.
Stone Chips				
$\frac{3}{4}$ " (2 cm.)	6 cuft	—	18.3 cum	—
Stone Chips				
$\frac{1}{2}$ " (12 mm.)	—	6 cuft	—	18.3 cu. m.
Stone Chips				
$\frac{3}{8}$ " (10 mm.)	4	—	12 cu.m .	—
Stone Chips				
$\frac{1}{4}$ " (6 mm.)	2	3	6 cu.m.	9 cu. m.
Socofix	42 lbs.	33 lbs.	2050 kg.	1612 kg.

### C. LABOUR REQUIRED:

Labour days	1	4/5	107	86
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## D. EQUIPMENT REQUIRED:

Roller

Mixer — Power driver or hand operated

Small tools (page 61)

## E. ESTIMATED COST COMPLETE:

(Excluding Tack Coat)

Rs. 20

15

2153

1615

**NOTE: LABOUR:** The labour estimates are based on the assumption that a power mixer will be used. If mixing is by hand or in drum mixers the labour requirements should be increased by about 50%.

**ROLLER:** One roller can roll 10,000 to 12,000 sq. ft. (930 to 1115 sq. m.) per day.

**BOILER:** One boiler can heat  $1\frac{1}{2}$  to 2 charges daily.

**TACK COAT:** The above estimates of materials and labour do not include the Tack Coat. If the Tack Coat is being laid over a black top surface provide for 10 to 15 lbs. per 100 sq. ft. (490 to 735 kg. per 1000 sq. m.). On a water-bound surface provide for 15 to 20 lbs. per 100 sq. ft. (735 to 975 kg. per 1000 sq. m.).

**TACK COAT** may be given with the same cutback binder used for premix.

## F. PROCEDURE:

**1. Preparation of Premix:** Batches should be proportioned according to the capacity of the mixer used. The premix should preferably be prepared about 2 days in advance of use to allow time for volatiles to partially escape (page 70).

a) Place the correct batch quantity of aggregate in the mixer and pour over it its proportionate quantity of Socofix.

b) Continue mixing until the aggregate is uniformly coated.

**2. Construction:** (All pot-holes and depressions in the base should be made good before the work is started. If the premix is laid over a black top

surface the procedure described on page 107 is recommended for patching all pot holes. If the premix is laid over a structure not previously surfaced the material of which the structure is originally built can be used for patching pot-holes).

- (a) Brush the base clean (Page 62).
- (b) If the surface has been black topped already apply tack coat at 10 to 15 lbs. per 100 sq. ft. (490 to 735 kg. per 1000 sq.m.). On untreated surface apply tack coat at 15 to 20 lbs. per 100 sq. ft. (735 to 975 kg. per 1000 sq.m.). Tack coat may be applied with the same cutback binder used for the premix.
- (c) Paint the edges of all kerbs, manholes etc. with Socofix (Page 71).
- (d) Spread the premix at the rate specified and in a uniform layer (Page 71) and allow it to cure overnight.
- (e) Roll with a power roller. Check for grade and camber during rolling and add or remove premix as required (Page 73).
- (f) Keep closed to traffic for 24 hours if possible.

### **3. SEAL COAT:**

A seal coat is not always necessary but it is desirable and is recommended particularly in localities where rainfall is heavy. If it is decided to apply a seal coat at once then a premixed sand seal coat according to the Sheet Macadam specification on page 128 is recommended. If a liquid seal coat is preferred its application should be delayed until the premix is set hard.

# STANVAC ASPHALTIC CONCRETE

## (Cold Process)

1" (2.5 cm.) Dense Graded Premixed Carpet.

- A. GENERAL DESCRIPTION: This specification provides for the construction of a Stanvac Asphaltic Concrete surface course which consists of a mixture of coarse and fine mineral aggregate and cold application cutback asphalt binder Socofix laid over a suitable base to a thickness of 1" (2.5 cm.). It is particularly suitable for small projects such as surfacing railway station platforms where it is uneconomical to move boilers to the job. It is also suitable for surfacing and resurfacing airport runways carrying moderate air traffic. All materials are used without heating.

B. MATERIALS REQUIRED:

	Per 100 sq. ft.	Per 1000 sq.m.
Stone Chips $\frac{3}{4}$ " (2 cm)	5 cu.ft.	15.25 cu.m.
Stone Chips $\frac{3}{8}$ " (10 mm.)	3 cu.ft.	9 cu.m.
Sand	4 cu.ft.	12 cu.m.
Socofix	53 lb.	2590 kg.

C. LABOUR REQUIRED:

Labourer Days	1	107
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D. EQUIPMENT REQUIRED:

Roller

Mixer-Power driven Pug Mill type (page 71).

Small tools (page 61).

## E. ESTIMATED COST COMPLETE:

(Excluding Tack Coat)

Rs. 20.75

Rs. 2230.00

**NOTE: LABOUR:** The labour estimate is based on the assumption that a power mixer will be used. If mixing is by hand or in drum mixers labour requirements will be an additional 50 per cent.

**ROLLER:** Our roller can roll 10,000 to 12,000 sq. ft. (930 to 1115 sq.m.) per day.

**TACK COAT:** The above estimates of material and labour do not include the tack coat. If the premix is being laid over a black top surface provide for 10 to 15 lbs. per 100 sq. ft. (490 to 735 kg. per 1000 sq.m.). On a waterbound surface provide for 15 to 20 lbs. per 100 sq. ft. (735 to 975 kg. per 1000 sq.m.). Tack Coat may be given with same cutback binder used for the premix.

## F. PROCEDURE:

**Preparation of Premix:** Batches should be proportioned in accordance with the capacity of the mixer being used. The premix should be preferably prepared about 2 days in advance of use to allow time for the volatiles to partially evaporate (page 70).

a—Place the stone in the mixer and pour on to it approximately  $\frac{2}{3}$  of the batch quantity of Socofix. Mix until the stone is uniformly coated.

b—Add sand and continue mixing until the sand is uniformly distributed throughout the mix.

c—Add the remaining batch quantity of Socofix and continue mixing until it is uniformly mixed in.

**Construction:** All pot-holes and depression in the base should be made good before work commences. If the premix is being laid over a black top surface the procedure described on page 107 is recommended for patching all pot-holes. If the premix is being laid over a structure not previously surfaced

the material of which the structure is built can be used for patching pot-holes.

a—Brush the base clean (page 62).

b—If the surface has been previously black topped apply tack coat at 10 to 15 lbs. per 100 sq. ft. (490 to 735 kg. per 1000 sq.m.). On untreated surface apply tack coat at 15 to 20 lb. per 100 sq. ft. (735 to 975 kg. per 1000 sq.m.). Tack coat may be applied with the same cutback binder used for the premix.

c—Paint the edges of all kerbs, manholes etc. with the binder used in the premix (page 71).

d—Spread premix in a uniform layer at the rate specified (page 71) and allow it to cure overnight.

e—Roll with a power roller. Check for grade and camber during rolling and add or remove premix as required (page 73).

f—Keep closed to traffic for 24 hours.

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## HEAVY CARPETS

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- HOT PROCESS

1½", 2" and 2½" Premixed Macadam

1½" 2" and 2½" Asphaltic Contrete

# STANVAC PREMIXED ASPHALT MACADAM

(Hot Process)

1½" to 2½" (4 to 6 cm.) Open Graded Premixed Carpet

A. GENERAL DESCRIPTION: This specification provides for the construction of a Stanvac Premixed Asphalt Macadam surface course which consists of a mixture of graded broken stone metal and cutback asphalt binder (Stanvac Paving Asphalt 30/40 or 60/70 or 80/100 mixed with solvent Socosol) laid in two courses over a suitable base. The stone is used without heating. The asphalt is used at a temperature of 325° to 350°F (163° to 177°C).

## B. MATERIALS REQUIRED:

Finished Thickness	Per 100 sq.ft.		
	2½"	2"	1½"
<b>Base Course</b>			
1½" Stone	16 cu.ft.	12 cu.ft.	—
1" Stone	—	—	8 cu.ft.
¾" Stone	8 cu.ft.	6 cu.ft.	—
½" Stone	—	—	4 cu.ft.
Stanvac Paving Asphalt			
30/40, 60/70			
or 80/100	71 lbs.	54 lbs.	36 lbs.
Socosol	4.5 lbs.	3 lbs.	2 lbs.
<b>Wearing Course</b>			
½" Stone	5 cu.ft.	5 cu.ft.	5 cu.ft.
¼" Stone	2 cu.ft.	2 cu.ft.	2 cu.ft.
Stanvac Paving Asphalt			
30/40, 60/70			
or 80/100	22 lbs.	22 lbs.	22 lbs.
Socosol	1.5 lbs.	1.5 lbs.	1.5 lbs.

## C. LABOUR REQUIRED:

Labour days	2½	2½	1½
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## D. ESTIMATED COST COMPLETE

(Excluding Primer) Rs. 44/50 Rs. 38/00 Rs. 32/00

## MATERIALS REQUIRED: (METRIC UNITS)

Finished Thickness	Per 1000 sq.m.		
	6 cm.	5 cm.	4 cm.
<b>Base Course</b>			
4 cm. Stone			
Metal	48 cu.m.	36.5 cu.m.	—
2.5 cm. Stone			
Metal	—	—	24.5 cu.m.
2 cm. Stone			
Metal	24.5 cu.m.	18.25 cu.m.	—
12 mm. Stone			
Metal	—	—	12 cu.m.
Stanvac Paving Asphalt			
30/40 or 60/70			
or 80/100	3460 kg.	2630 kg.	1760 kg.
Socosol	210 kg.	155 kg.	100 kg.
<b>Wearing Course</b>			
12 mm. Stone			
Metal	15.25 cu.m.	15.25 cu.m.	15.25 cu.m.
6 mm. Stone			
Metal	6 cu.m.	6 cu.m.	6 cu.m.
Stanvac Paving Asphalt			
30/40 or 60/70			
or 80/100	1075 kg.	1075 kg.	1075 kg.
Socosol	65 kg.	65 kg.	65 kg.
<b>C. LABOUR REQUIRED:</b>			
Labour days	268	228	188
<b>D. ESTIMATED COST COMPLETE</b>			
(Excluding Primer)	Rs. 4790	Rs. 4090	Rs. 3440

## **E. EQUIPMENT REQUIRED:**

Small Tools (page 61).

Roller (10 Tons minimum)

Boiler

Power driven mixer, Pug Mill type if available

**NOTE: LABOUR:** The labour estimates are based on the assumption that a power mixer will be used. If mixing is done in drum mixers the labour requirements will be twice that indicated above.

**ROLLER:** One roller can roll 10,000 to 12,000 sq. ft. (930 to 1115 sq.m.) per day of either base course or surface course.

**BOILER:** One boiler can heat  $1\frac{1}{2}$  to 2 charges daily.

**TACK COAT:** The above estimates of material and labour requirements and costs do not include the tack coat. If the premix is being laid over a black top surface provide for a tack coat of 10 to 15 lbs. per 100 sq. ft. (490 to 735 kg. per 1000 sq.m.) of the same binder used in the premix. On waterbound surfaces provide for 15 to 20 lbs. per 100 sq. ft. (735 to 975 kg. per 1000 sq.m.).

## **F. PROCEDURE:**

**1. Preparation of Premix:** (Batches should be proportioned according to the capacity of the mixer).

- a) The correct batch quantity of asphalt heated to a temperature of 325 to 350°F (163 to 177°C) should be drawn off from a boiler into a container and the proportionate quantity of Socosol added thereto while stirring the asphalt. Generally 1 oz. of Socosol is used per pound of asphalt (about 6%) but the proportions can be varied to suit the climatic conditions (page 69).
- b) Place the correct quantity of aggregate in the mixer and pour over it its proportionate quantity of cutback asphalt prepared as described under (a) above.

- c) Continue mixing until the aggregate is uniformly coated.

## **2. CONSTRUCTION:**

(All pot-holes and depressions in the base should be made good before work commences. If the premix is being laid over a black top surface the procedure described on page 104 is recommended for patching all pot-holes. If the premix is being laid over a structure not previously surfaced the material of which the structure is built can be used for patching pot-holes).

- a) Brush the base clean (page 62).
- b) Apply tack coat at the specified rate.
- c) Paint the edges of all kerbs, manholes, etc. with the binder used in the premix (page 71).
- d) Spread the base course premix at the rate specified in a uniform layer (page 71).
- e) Roll with a power roller after an interval of 3 to 6 hours. Check for grade and camber during rolling and add or remove premix as required (page 73).
- f) When the base course has been lightly rolled, spread the wearing course premix at the rate specified and roll again.

- 3. **SEAL COAT:** A seal coat is not always necessary but it will add to the life of the structure and is recommended – particularly in localities where rainfall is heavy. It may be applied immediately following construction or at a later date as may be specified by the Engineer-in-charge. It should be applied according to specification for repainting contained on page 93.

## STANVAC ASPHALTIC CONCRETE

(Hot Process – Cold Laid)

1½" to 2½" (4 to 6 cm.) Dense Graded Premixed Carpet

- A. GENERAL DESCRIPTION: This specification provides for the construction of a Stanvac Asphaltic Concrete surface course which consists of a mixture of coarse and fine mineral aggregate and hot cut-back asphalt binder (Stanvac Paving Asphalt 30/40 or 60/70 or 80/100 mixed with solvent Socosol) laid in one course over a suitable base. It is recommended particularly where a dense heavy duty carpet is desired. The aggregate may be used without heating. The asphalt is used at a temperature of 325° to 350°F (163° to 177°C).

### B. MATERIALS REQUIRED:

Finished Thickness	Per 100 sq.ft.		
	2½"	2"	1½"
1½" Stone	12 cu.ft.	10 cu.ft.	—
1" Stone	8 cu.ft.	6 cu.ft.	8 cu.ft.
¾" Stone	—	—	4 cu.ft.
Sand	10 cu.ft.	8 cu.ft.	6 cu.ft.
Stanvac Paving Asphalt 30/40 or 60/70 or 80/100	124 lbs.	102 lbs.	78 lbs.
Socosol	8 lbs.	6 lbs.	5 lbs.

### C. LABOUR REQUIRED:

Labourer days	2½	2	1-2/3
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### D. ESTIMATED COST COMPLETE:

(Excluding Primer) Rs. 45/00 Rs. 36/25 Rs. 29/00

**B. MATERIALS REQUIRED: (METRIC UNITS)**

		Per 1,000 sq.m.		
Finished Thickness 6 cm.		5 cm.	4 cm.	
4 cm. Stone				
Metal	36 cu.m.	30 cu.m.	—	
2.5 cm. Stone				
Metal	24.5 cu.m.	18 cu.m.	24.5 cu.m.	
2 cm. Stone				
Metal	—	—	12 cu.m.	
Sand	30 cu.m.	24 cu.m.	18 cu.m.	
Stanvac Paving Asphalt 30/40 or 60/70 or 80/100	6000 kg.	4950 kg.	3825 kg.	
Socosol	370 kg.	300 kg.	230 kg.	

**C. LABOUR REQUIRED:**

Labourer days	242	215	180
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**D. ESTIMATED COST COMPLETE:**

(Excluding Primer) Rs. 4840 Rs. 3900 Rs. 3120

**E. EQUIPMENT REQUIRED:**

Small Tools (page 61)

Roller

Boiler

Mixer Power driven Pug Mill type (page 71)

**NOTE: LABOUR**—The labour estimates are based on the assumption that a power mixer will be used. Mixing by hand or in drum mixers is not recommended for this process.

**ROLLER**—One roller can roll 10,000 to 12,000 sq. ft. (930 to 1,115 sq.m.) per day.

**BOILER**—One boiler can heat  $1\frac{1}{2}$  to 2 charges daily.

**TACK COAT**—The above estimates of material and labour requirements do not include the tack coat. If the premix is being laid over a black top surface provide for a tack coat of 10 to 15 lbs. per 100 s.ft. (490 to 735 kg. per 1000 sq.m.) of the same binder used in the premix. On water bound surfaces provide for 15 to 20 lb. per 100 s.ft. (735 to 975 kg. per 1000 sq.m.)

## F. PROCEDURE:

1. Preparation of Premix (Batches should be proportioned according to the capacity of the mixer).

a—The correct batch quantity of Stanvac Paving Asphalt 30/40 or 60/70 or 80/100 heated to temperature of 325 to 350°F. (163 to 177°C) should be drawn off from the boiler into a suitable container and the proportionate quantity of Socosol added thereto while stirring the asphalt. Generally 1 oz. of Socosol is used per lb. of asphalt (about 6%) but the proportions can be varied to suit climatic conditions (page 69).

b—Place the stone in the mixer and pour on it approximately  $\frac{2}{3}$ rd of the batch quantity of cutback asphalt prepared as described under (a) above. Mix until the stone is uniformly coated.

c—Add the sand and continue mixing until the sand is uniformly distributed throughout the mix.

d—Add the remaining batch quantity of asphalt and continue mixing until it is uniformly mixed in.

## **2. CONSTRUCTION:**

**All pot-holes and depressions in the base should be made good before work commences. If the premix is being laid over a black top surface the procedure described on page 104 is recommended for patching all pot holes. If the premix is being laid over a structure not previously surfaced, the material of which the structure is built can be used for patching pot-holes.**

- a—Brush the base clean (pages 62).**
- b—Apply tack coat at the specified rate.**
- c—Paint the edges of all kerbs, manholes, etc., with the binder used in the premix (page 71).**
- d—Spread the prepared premix at the rate specified and in a uniform layer (page 71).**
- e—Roll to compaction with a power roller after an interval of 3 to 6 hours. Check for grade and camber during rolling and add or remove premix as required (page 73).**
- f—During rolling any open textured areas should be closed by sand premixed with the asphalt binder in the proportions specified on page 40.**



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## **HOT-MIX HOT-LAID ASPHALTIC CONCRETE**

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## **HOT-MIX HOT-LAID ASPHALTIC CONCRETE**

1. **GENERAL:** The specifications given in the preceding pages have all been based on past experience in the field. While roads constructed with these specifications continue to give service the type of surfacing adopted has essentially been on considerations of initial economy and available construction equipment. Asphalt is a very versatile material and can withstand a surprisingly great deal of misuse. However, as with all construction materials, proper design and construction of asphalt pavements will result in improved field performance and ultimate economy by way of reduced repair costs and fewer renewals.

Currently hot-mix hot-laid asphaltic concrete specifications are adopted only in the Municipal limits of big cities. However with the increasing traffic and the heavier loads expected on India's roads due to the industrialization envisaged in the successive Five-year plans it will be necessary to provide heavy duty surfaces on important rural roads. Hot-mix hot-laid asphaltic concrete pavements have, over the past years, proved their worth in meeting all requirements of heavy duty roads all over the world. However for best results it is essential to design these paving mixes in the laboratory and to ensure implementation of design results in the field. In this chapter we have outlined the basic principals of design of hot-mix hot-laid paving mixes; further details will be available on application to our nearest office (Page 224).

2. **DEFINITION OF HOT-MIX:** Hot-mix asphalt paving consists of a combination of aggregates uniformly mixed and coated with asphalt. To dry the aggregate and obtain sufficient fluidity of the asphalt for proper mixing and workability both the aggregate and the asphalt must be heated prior to mixing—hence the term "hot-mix."

The aggregates and asphalt are combined in an asphalt-mixing plant in which the desired paving mix is produced. The hot-mix is then transported to the job site and spread by motor patrol, paving or finishing machine in a loosely-compacted layer with a uniform, smooth surface. While the paving mix is still hot, it is further compacted by heavy rollers to produce a smooth dense course.

**3. CLASSIFICATION OF HOT-MIX ASPHALT PAVING:** Asphalt paving mixes may be produced from a wide range of aggregate combinations, each having its own particular characteristics and suited to specific design and construction uses. The Asphalt Institute has adopted the following characteristics for classifying hot-mix asphalt paving by determining the relative amounts of:

Coarse Aggregate	(retained on No. 8 Sieve)
Fine Aggregate	(passing No. 8 Sieve)
Mineral Dust	(passing No. 200 Sieve)

The aggregate composition may vary from a coarse-textured mix having a predominance of coarse aggregate to a fine-textured mix having a predominance of fine aggregate.

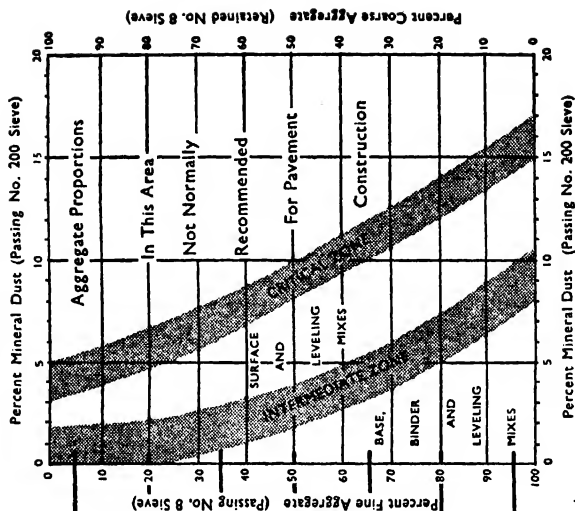
To give general expression to these variables, The Asphalt Institute classifies hot-mix asphalt paving according to MIX TYPE, based on relative amounts of coarse aggregate, fine aggregate and mineral dust (filler). The general limits for each MIX-TYPE ("I" to "VIII") are set forth in the chart on following page which along with the paving mix designation indicates the maximum size aggregate normally used for each of the eight mix types.

The chart gives primary consideration to the proportion of coarse and fine aggregate in the paving mix used

# CLASSIFICATION OF HOT-MIX ASPHALT PAVING

PAVING MIX DESIGNATION		MAXIMUM SIZE AGGREGATE NORMALLY USED	
Type	Description	Surface and Leveling Mixes	Base, Binder and Leveling Mixes
I	MACADAM		2 $\frac{1}{2}$ " (6 cm)
II	OPEN GRADED	$\frac{3}{4}$ " - $\frac{1}{2}$ " (1-2 cm)	$\frac{3}{4}$ " - 1 $\frac{1}{2}$ " (2-4 cm)
III	COARSE GRADED	$\frac{1}{2}$ " - $\frac{3}{4}$ " (12 mm-2 cm)	$\frac{3}{4}$ " - 1 $\frac{1}{2}$ " (2-4 cm)
IV	DENSE GRADED	$\frac{3}{4}$ " - 1" (12 mm-2 1/2 cm)	1" - 1 $\frac{1}{2}$ " (2 1/2 - 4 cm)
V	FINE GRADED	$\frac{3}{4}$ " - $\frac{3}{8}$ " (12 mm-2 cm)	$\frac{3}{4}$ " (2 cm)
VI	STONE SHEET	1" - $\frac{3}{4}$ " (12 mm-2 cm)	$\frac{3}{8}$ " (2 cm)
VII	SAND SHEET	$\frac{3}{8}$ " (1 cm)	
VIII	FINE SHEET	No. 4	No. 4

## AGGREGATE COMBINATIONS



1 CRITICAL ZONE DUST CONTENTS IN THIS REGION SHOULD NOT BE USED WITHOUT A SUBSTANTIAL BACKGROUND OF EXPERIENCE WITH SUCH MIXES AND/OR SUITABLE JUSTIFICATION BY LABORATORY DESIGN TESTS.

2 INTERMEDIATE ZONE DUST CONTENTS IN THIS REGION SOMETIMES USED IN SURFACE AND LEVELING MIXES AS WELL AS IN BASE AND BINDER MIXES.

to establish the MIX TYPE. Of equal importance is the proportion of mineral dust or filler, the ranges of which are represented by shaded bands.

The area of the classification chart to the left of the shaded band includes the range of mineral dust for each respective MIX TYPE, including surface course, binder course (sometimes called intermediate course) and base course mixes. For any given combination of coarse and fine aggregate (i.e. MIX TYPE) surface course mixes will normally contain relatively more mineral dust than either base or binder mixes, and the base mixes will normally contain the least amount of mineral dust. Therefore, for particular MIX TYPE, base and binder course mixes will normally fall on the left side of the Chart as indicated and surface course mixes to the right of these base and binder course mixes. Levelling course mixes may fall in either area. It should be emphasized, however, that there are exceptions.

4. MIX DESIGN: For proper mix design laboratory facilities are essential. The design of asphalt paving mixes, as with other engineering materials, is largely a matter of selecting and proportioning materials to obtain the desired qualities and properties in the finished construction. To attain this several design methods e.g. the Marshal Method, the Hubbard-Field Method, the Hveem Method, the Smith Triaxial Method and the Taylor Method can be used. For each of these methods, the procedures, testing and equipment requirements conform to "standard" procedures prescribed by the originator of the respective mix design method.

Regardless of the design method used, the overall objective for the design of asphalt paving mixes is to determine an economical blend and gradation of aggregates and a corresponding asphalt content that yields a mix having:

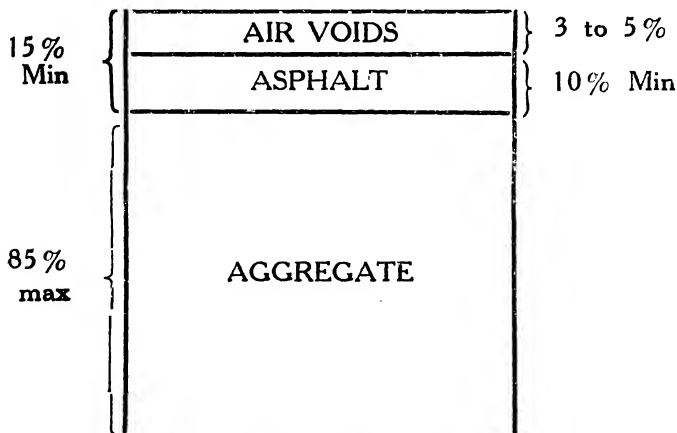
(a) Sufficient asphalt to coat thoroughly the aggregate particles and to waterproof and bond them together to insure a durable pavement under suitable compaction.

(b) Sufficient mix stability (as provided under the specific design method used) to satisfy the service requirements and demands of traffic without distortion or displacement.

(c) Sufficient voids in total compacted mix to provide a reservoir of space for expansion of asphalt and for a slight amount of additional compaction under traffic loading.

(d) Sufficient workability to permit the placement of the paving mix as an efficient construction operation.

Keeping in mind the above design criteria the following figure illustrates an excellent design for dense graded asphalt concrete on volumetric basis.



Asphalt paving mixtures should be designed on a volume basis and the figures so obtained converted to

weight basis for actual mixing operations. The above figure illustrates that the air voids in the compacted mix should be within the range of 3 to 5 % while the aggregates should fill not more than 85 % of the volume of the thoroughly compacted mixture. This leaves a minimum volume of 10 % for the asphalt.

4-1. AIR VOIDS: If the voids in the mineral aggregate are less than 15 % and sufficient asphalt is added for durability, the air voids that remain are very low and approach zero. Such a mixture when thoroughly compacted is subject to flushing of asphalt to the surface and if the air voids become zero, the pavement loses stability and tends to "shove" or "push" resulting in a corrugated surface. On the other hand, if a pavement made with extremely dense graded aggregate contains the required 3 to 5 percent air voids, the asphalt content must be less than 10 per cent by volume. This results in a pavement that is too lean and that tends to unravel under traffic. If the air voids in the compacted mixture are over 5 per cent the pavement will not be sufficiently waterproof.

There are three methods of increasing the voids in the mineral aggregate viz.

(a) By increasing the percentage of fine aggregate. It is obvious that if for any coarse aggregate particle, say 3/4 inch (2 cm.) size in a paving mixture, an equal volume of compacted sand is substituted, a decrease in aggregate volume will result because compacted sand consists not only of the sand grains, but also of the void spaces between the particles. However, increasing the fine aggregate percentage cannot be carried too far when it consists of natural sands since a very large content of fine aggregate may seriously reduce the stability of the paving mixture.

(b) By increasing the percentage of the fine sand in the fine aggregate. Here again the percentage of

fine sand should not be increased without verifying its effect on stability.

(c) By reducing the percentage of material passing No. 200 Sieve. Since the earliest development of asphalt pavements, mineral filler (material passing No. 200 sieve) has been considered as an essential ingredient. Laboratory tests have shown that mineral filler goes into the void spaces between the coarse and fine aggregate particles. Consequently, if the volume of the total mineral aggregate already exceeds 85 % of the volume of a compacted paving mixture, adding mineral filler (which becomes part of the mineral aggregate) still further increases the volume occupied by the aggregate thus leaving insufficient voids in the mineral aggregate. Therefore mineral filler should be used only when the voids in the mineral aggregate are excessive.

**4.2. DURABILITY:** It has been mentioned that the asphalt content of a paving mixture must be sufficient to obtain a durable pavement. Experience shows that an asphaltic concrete paving mixture should contain not less than 10 % asphalt by volume. In the design of paving mixtures, one of the major objectives is to determine the optimum asphalt content and select the aggregate combination which permits a relatively high percentage while maintaining the air voids in the compacted mix between 3 and 5 per cent and the V.M.A. (Voids in Mineral Aggregate) above 15 percent.

Optimum asphalt content is affected by many factors. One of them is the gradation of the aggregate. The percentage of asphalt required to produce a given percentage of air voids increases as the percentage of fine aggregate increases. If fine sand is substituted for well graded fine aggregate, the amount of asphalt has to be increased to obtain the same percentage of air voids.

Another factor which affects the required asphalt content is the mineral filler in the mixture. It has been

stated previously that the mineral filler is a void filling material. Consequently, if the voids in the compacted mix have to be kept between 3 and 5 % and the voids in the mineral aggregate (V.M.A.) above 15 per cent, the asphalt content has to be reduced if filler is added. Therefore, the addition of mineral filler can affect durability and should not be considered unless carefully performed laboratory tests indicate that it is really required and that it would improve the overall characteristics of the paving mixture.

Yet another factor which affects the required asphalt content is the absorption of the asphalt by the aggregate. The amount of asphalt absorbed depends upon the type of aggregate. It can be negligible or it can be as much as 2 per cent or even higher. The quantity of asphalt absorbed is not available as a binder and if no correction is made for it, the calculated optimum asphalt content will produce a lean mix when laid on the road.

4.3. STABILITY. In addition to durability, an asphalt mix must have sufficient stability to resist displacement under the heaviest wheel loads to which it will be subjected. Proper evaluation of stability can be made in the laboratory by either the Marshall Method or the Hubbard-Field Method or The Hveem Method or The Smith Triaxial Method or The Taylor Method. All these methods are empirical but have been correlated with actual field performance. Due to limitations of space it is not our intention to describe these methods here but full details can be obtained on application to our nearest office (Page 224).

Depending on its quantity in the mix, asphalt can act either as a binder or as a lubricant. Therefore, the stability of a paving mixture increases with an increase in the asphalt content until a maximum is reached, after which it falls off. The asphalt content may be more critical with certain gradations and types of aggregates than with others.

The viscosity of the asphalt at the test temperature has a large effect on stability. Generally high viscosity asphalts will produce high stability. However it must be remembered that from a standpoint of durability, the asphalt should be as soft as stability will allow. For all service requirements, the test methods give the minimum stabilities necessary and it is preferable to choose a softer asphalt provided the stability of the mix is above the minimum specified.

In general, the larger the maximum size of the aggregate, the higher the stability of the paving mixture. However when working with mechanical spreaders the maximum size is usually limited to  $\frac{3}{4}$ " (2 cm.) for surface courses.

The proportion of different sizes of aggregate particles has a very large influence on stability. When combining a coarse and fine aggregate, there is an optimum proportion that produces maximum stability. Also the percentage of mineral filler in the mix has a large effect on stability. When air voids are kept constant which requires lowering of asphalt content with an increase in the quantity of filler, a very small quantity is sufficient to increase the stability.

The shape of the particles of the mineral aggregate, their surface texture and hardness also influence the stability of the mix. For example an uncrushed gravel with smooth and round particles will produce less stability than a crushed material with particles having a rough surface and hard edges. Similarly the type of sand and its quantity affect the stability of asphaltic concrete.

The density of a mix has a very large bearing on its stability, but maximum stability does not always occur at the maximum density as the asphalt content that produces maximum density may be so much as to produce a lubricating effect.

It is evident that many factors contribute to the quality of an asphalt pavement. Most of these factors are inter-related. The performance of a pavement depends upon the combined characteristics of all the components as also the care and control ensured during construction.

The main function of the mineral aggregate is to impart the necessary stability to the pavement. However, it also has a very large bearing on durability, mostly because it controls the quantity of asphalt.

The asphalt binder has an influence on all the properties of the pavement but it is on durability that its effects are more prominent. Any quality test on asphalt binder should primarily evaluate this property. While it is important for the asphalt binder to have the right properties, it is even more important that the pavement be properly designed and constructed.

**5. GRADATION OF AGGREGATES:** The analysis of aggregate gradations and combining of aggregates to obtain the desired gradation are important steps in hot-mix design. The total aggregate gradation must first meet the gradation requirements of the job and yield a mix design that meets the criteria of the design method. Also the total gradation should be such that it utilizes economically the aggregate available in the vicinity of the construction.

The following outlines the schedule of laboratory operations that normally apply to the testing and analysis of aggregates for preliminary mix designs. It will be necessary at times to modify this schedule to suit the testing requirements that arise during the progress of the mix design.

- (a) Dry all aggregate samples to constant weight at 230°F (110°C). Separate pans should be used for each aggregate sample.

- (b) Perform sieve analysis (washed) and specific gravity tests on each representative sample, including the filler, from each proposed aggregate source.
- (c) Complete blend of aggregate required to produce the desired mix gradation, using the total gradation for each aggregate source. For preliminary or exploratory mix designs it is usually advisable to make the initial trial mixes using an aggregate gradation that approaches the median of the specification limits.
- (d) Blend the aggregate from each source in proportions and amounts to produce the total amount of aggregate required for one trial mix series of the desired gradation. It is usually not desirable to blend in the main source of fillers at this time. For example the gradation analysis of Aggregates A & B and Sandy Filler C indicate that these three aggregates should be blended 50 %, 40 % and 10 % respectively, to produce the required gradation, Thus if a total of 20 kg. of aggregate are required for one trial mix series, 10 kg. of Aggregate A and 8 kg. of Aggregate B should be blended together as a uniform mixture. The remaining 2 kg. of Sandy Filler C, however, should be blended directly into the batch mixes.
- (a) Size the blended aggregates by dry sieving into fractions. The following sizes are recommended
- larger than  $\frac{3}{4}$ " (2 cm.)
  - $\frac{3}{4}$ " to  $\frac{3}{8}$ " (2 to 1 cm.)
  - $\frac{3}{8}$ " (1 cm.) to No. 4 sieve
  - No. 4 to No. 8 sieve
  - passing No. 8 sieve

The size separations may vary depending on the grading of the aggregate and on the aggregate heating and screening facilities available. The sizing of the main source of filler is usually not advisable, except where the total material contains an appreciable amount of coarse sizes.

- (f) Perform a sieve analysis (washed) on a representative sample from each size fraction of aggregate and on a representative sample of unsized filler.
- (g) Compute the blend proportions and batch weights of the sized aggregates and filler required to produce one batch mix of the desired gradation. As a matter of convenience it is desirable to use the same weight of aggregate for each batch in a trial mix series.
- (h) Prepare test specimens and design mix in accordance with the procedure prescribed for the particular Mix Design Method being used.

## 6. DENSITY & VOID CONTENT ANALYSES:

It has been previously stated that the mix should be designed on a volumetric basis and the results converted to weight basis for actual mixing operations. Therefore after determining the sieve analysis of the mineral aggregate it is necessary to ascertain separately and accurately the specific gravities of asphalt, coarse aggregate, fine aggregate and filler used in the mix.

(a) Asphalt Binder — The specific gravity of the asphalt is determined at 77°F (25°C) by ASTM method D 70 or equivalent.

(b) The mineral aggregate used for hot mix paving usually consists of crushed stone, crushed or uncrushed gravel and sand and/or stone screenings. Individual

fragments of these materials usually contain a certain amount of permeable voids or pore spaces depending upon the nature of the aggregate. For this reason two methods have been developed to express the specific gravity of aggregates, namely, "bulk specific gravity" and "apparent specific gravity." Simple and general definitions of these two terms are

$$\begin{aligned} \text{Bulk Specific Gravity} &= \frac{\text{Weight of Aggregate}}{\text{Volume of Aggregate (including permeable voids)}} \\ \text{Apparent Specific Gravity} &= \frac{\text{Weight of Aggregate}}{\text{Volume of Aggregate (excluding permeable voids)}} \end{aligned}$$

Therefore, the essential difference between "bulk" and "apparent" specific gravity is that the permeable voids are included in the volume of the aggregate for determination of bulk specific gravity and excluded from the volume of the aggregate in the case of apparent specific gravity. These values will depend upon the amount of permeable voids in the aggregate and in all instances the "bulk" specific gravity will be less than the "apparent" specific gravity.

In computations of specific gravity, water absorption is normally used to evaluate the amount of permeable voids. (See ASTM Methods 127 and 128 for specific gravities of coarse and fine aggregates respectively). The amount of water which will be absorbed by a given porous aggregate particle is usually greater than the amount of asphalt which will be absorbed by this same particle. The "bulk" specific gravity deter-

mined by water absorption is therefore less than the "bulk" specific gravity by asphalt absorption. On the other hand permeable voids do absorb a certain amount of asphalt and the "apparent" specific gravity by water absorption is greater than the specific gravity by asphalt absorption. The "effective" specific gravity of aggregates in asphalt paving mixtures, therefore, is normally between the "bulk" and "apparent" specific gravities determined by water absorption. However it should be noted that at present time there is no method of determining "effective" specific gravity which is universally accepted. Therefore, when designing a mix by any particular mix design method the specific gravity should be determined as indicated in the outline of the method. Certain methods of mix design are based on "bulk" specific gravity of aggregates while others on "apparent" specific gravity. In either case, the calculations for density and void analysis are the same.

**6.1. PROPORTIONING ASPHALT AND AGGREGATE:** In the proportioning of asphalt and aggregate it is important to note that the asphalt content may be expressed either as a percentage by weight of total mix or as a percentage by weight of dry aggregate. Each method of specifying asphalt content has certain advantages and either method is acceptable provided it is clearly understood which method is being used. The following example illustrates the two methods.

Assume that a given mix contains aggregates and asphalt in the proportion of 100 lbs. of aggregate to 6 lbs. of asphalt. The asphalt content of such a mix could be expressed as 6% asphalt by weight of dry aggregate. The same asphalt content may also be expressed as  $\left(\frac{6}{100+6}\right)100 = 5.66\%$  asphalt by weight of total mix.

## 7. SAMPLE TRIAL MIX

In order to illustrate the foregoing the following outlines the method of analyzing the density and voids for a mix design where the aggregate composition and specific gravities of the constituents are known. Sample briquettes are then prepared to determine the characteristics of the mix.

Assume that a particular mix has the following basic data

Constituent Material	Specific Gravity	Mix Composition % by weight of total mix	Aggregate Composition % by weight of total aggregate
80/100 Asphalt (as)	1.020	6.0	
Coarse Aggregate (ca)	2.58	52.0	55.3
Fine Aggregate (fa)	2.72	34.6	36.8
Mineral Filler (du)	2.70	7.4	7.9
		100 %	100 %

Note that the mix composition is expressed as percentage of total mix

### Bulk Density Data:

(a) Plain Uncoated Briquette: Height = 2.44 in  
Diameter = 4.00 in

Weight of Compacted Briquette  
in Air = 1174.7 gms.

Weight of Compacted Briquette  
in Water = 668.4 gms.

(b) Paraffin Coated Briquette:

Weight of Compacted Briquette  
in Air = 1220.9 gms.

Weight of Compacted Briquette  
in Water = 666.4 gms.

Bulk density of Paraffin = 0.90

**7.1. AVERAGE SPECIFIC GRAVITY OF TOTAL AGGREGATE** — Where the total aggregate consists of separate fractions of coarse aggregate, fine aggregate and dust, all having different specific gravities the calculations are simplified by determining the average specific gravity as follows:

$$G_{ag} = \frac{100}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \frac{P_3}{G_3}} \quad - - -$$

where  $G_{ag}$  = Average specific gravity of total aggregate.

$G_1, G_2, G_3$  = Specific gravity of coarse aggregate, fine aggregate and dust respectively.

$P_1, P_2, P_3$  = Percent total aggregate by weight of coarse aggregate, fine aggregate and dust respectively.

The average specific gravity of the above sample will therefore be

$$G_{ag} = \frac{100}{\frac{55.3}{2.58} + \frac{36.8}{2.72} + \frac{7.9}{2.70}} = 2.64$$

**7.2. WEIGHT — VOLUME RELATIONS:** The analysis of density and voids in a compacted hot-mix is simplified by visualizing the total weight as composed of the separate weights of asphalt, coarse aggregate, fine aggregate and filler while the total volume as consisting of the volumes of asphalt, coarse aggregate, fine aggregate, filler and VOIDS.

Thus the bulk volume (total) of a compacted briquette may be represented as

$$\begin{aligned} V_b &= V_v + V_1 + V_2 + \dots\dots\dots\text{etc.} \\ &= V_v + \frac{W_1}{G_1} + \frac{W_2}{G_2} + \dots\dots\dots\text{etc} \\ &= V_v + \frac{P_1}{G_1} + \frac{P_2}{G_2} + \dots\dots\dots\text{etc} \end{aligned}$$

where  $V_b$  = bulk volume (total) of the briquette

$V_v$  = volume of voids in the briquette

$V_1, W_1, G_1, P_1$ , etc = volume, weight, specific gravity and percentage of each constituent material in the compacted briquette.

**7.3. BULK DENSITY —** The bulk density of a compacted hot-mix briquette is determined by computing the ratio of its weight in air to its bulk volume. The bulk volume of the briquette may be determined and the bulk density calculated by one of the following three methods:

Method A applies to briquettes having a dense, impermeable surface texture. The bulk volume is determined as the difference between its weight in air and its weight (uncoated) in water.

For plain uncoated briquettes

$$Db = \frac{W_a}{V_b} = \frac{W_a}{W_a - W_w}$$

where  $Db$  = bulk density of the briquette

$V_b$  = bulk volume of the briquette

$W_a$  = weight of briquette in air

$W_w$  = weight of briquette in water

Therefore, the bulk density of the sample by this method will be

$$Db = \frac{1174.7}{1174.7 - 668.4} = 2.320$$

Method B applies to specimens having an open permeable surface texture. The bulk volume of this type of briquette is determined as the difference between its weight in air and its weight in water when quoted with paraffin.

For paraffin coated briquettes:

$$Db = \frac{W_a}{V_b} = \frac{W_a}{W_{ac} - W_{wc} - \frac{(W_{ac} - W_a)}{(G_p)}}$$

where  $Db$  = bulk density of coated briquette

$W_a$  = Weight of briquette (uncoated) in air

$W_{ac}$  = Weight of briquette plus paraffin coating in air.

$W_{wc}$  = Weight of briquette plus paraffin coating in water

$G_p$  = bulk specific gravity of paraffin

The bulk density by method B will be:

$$D_b = \frac{1174.7}{1220.9 - 664.4 - \frac{(1220.9 - 1174.7)}{(0.90)}} = 2.325$$

Method C applies to specimens having a dense, smooth surface texture and formed to dimensions that can be accurately measured. The bulk volume of the briquette is computed from the diameter and height measurements of the briquette

$$D_b = \frac{W_a}{V_b} = \frac{W_a}{12.87 d^2 h} \quad \text{where the height and diameter are in inches}$$

$$\text{or} = \frac{W_a}{.7854 d^2 h} \quad \text{where the height and diameters are in centimeters.}$$

By this method the bulk density of the sample will be

$$D_b = \frac{1174.7}{12.87(4)^2 (2.44)} = 2.338$$

**7.4. MAXIMUM THEORETICAL DENSITY:**  
The maximum theoretical density of a compacted hot-mix briquette represents the specific gravity or density value that would be theoretically obtained if the briquette were compressed to a voidless mass of asphalt and aggregate. From the weight-volume relations it follows that:

$$D_m = \frac{100}{\frac{P_{as}}{G_{as}} + \frac{P_{ag}}{G_{ag}}}$$

where  $D_m$  = maximum theoretical density

$P_{as}$  = percent of asphalt by weight of total mix

$P_{ag}$  = percent of aggregate by weight of total mix

$G_{as}$  = specific gravity of asphalt

$G_{ag}$  = specific gravity, average for total aggregate

The maximum theoretical density of the sample will therefore be

$$D_m = \frac{100}{\frac{6.0}{1.020} + \frac{94.0}{2.64}} = 2.41$$

7.5. PERCENT MAXIMUM DENSITY — The density (bulk) of a compacted hot-mix paving may also be expressed as a percentage of the maximum theoretical density as follows

$$\% D_m = \frac{D_b \times 100}{D_m}$$

where  $D_b$  = bulk density

$D_m$  = maximum theoretical density

The percent maximum density of the sample will be

$$\% D_m = \frac{2.32 \times 100}{2.41} = 96.3\%$$

7.6. PERCENT VOIDS IN COMPACTED MIX: The void content of the compacted mix represents the difference between the bulk volume of the compacted mix and the theoretical absolute volume of the asphalt

and the aggregate. This can either be calculated as follows or by the formula given in 7.8.

$$\begin{aligned}\% V_v &= 100 - \frac{\% D_m}{(D_b \times 100)} \\ &= 100 - \frac{(D_m)}{(D_m - D_b)} \text{ or} \\ \% V_v &= 100 \frac{(D_m - D_b)}{D_m}\end{aligned}$$

where  $V_v$  = Volume of voids as percent of total volume

$D_m$  = maximum theoretical density

$D_b$  = bulk density

Therefore the percent voids in the compacted sample will be

$$\% V_v = 100 \frac{(2.41 - 2.32)}{2.41} = 3.7\%$$

**7.7. VOLUMETRIC PROPORTIONS** — The volumetric proportions of the constituent materials in a compacted briquette are expressed as percentages by volume of the total volume of the specimen. Suppose "X" represents any constituent material in a compacted briquette, the volume of "X" in the briquette will be

$$V_x = \frac{W_x}{G_x} = \frac{P_x \cdot W_a}{100 \times G_x}$$

The percent of the total briquette volume occupied by "X" will be

$$\% V_x = \frac{V_x \times 100}{V_b} = \frac{P_x \cdot W_a}{G_x \cdot V_b}$$

where  $V_x$  = volume of "X" in the briquette in ccs.  
 $V_b$  = total volume of briquette in ccs.  
 $W_x$  = weight of "X" in briquette in gms.  
 $W_a$  = total weight of briquette in gms.  
 $P_x$  = percentage of "X" in the mix by weight  
 $G_x$  = specific gravity of "X"

$$\text{By definition Bulk Density of briquette } (D_b) = \frac{W_a}{V_b}$$

$$\text{therefore } \% V_x = \frac{P_x \cdot D_b}{G_x}$$

Therefore volumewise the sample consists of

$$\begin{array}{lcl}
 \% V_{as} = \frac{6.0 \times 2.32}{1.020} = 13.7\% \\
 \% V_{ca} = \frac{52.0 \times 2.32}{2.58} = 46.8\% \\
 \% V_{fa} = \frac{34.6 \times 2.32}{2.72} = 29.5\% \\
 \% V_{du} = \frac{7.4 \times 2.32}{2.70} = 6.3\% \\
 \left. \begin{array}{l} \\ \\ \\ \end{array} \right\} 82.6\% \\
 \\
 \% V_{ag} = \frac{94.0 \times 2.32}{2.64} = 82.6\% \quad \left. \right\} \text{(check)}
 \end{array}$$

7.8. With all the volumes of the constituent materials expressed as a percentage of the total volume of the briquette, it follows that their sum equals the total volume of the briquette ( $V_b$ ) or 100%. The percent volume of voids in the briquette will therefore be

$$\% V_v = 100 - \% V_{as} - \% V_{ag}$$

$$\text{and } \% \text{ Agg. Voids} = 100 - \% V_{ag}$$

$$\text{Therefore } \% \text{ Agg. Voids (filled with asphalt)} = \frac{\% V_{as}}{\% \text{ Agg. Voids}}$$

where  $\% V_{as}$  = volume of asphalt as percent total volume of specimen

$\% V_{ag}$  = volume of total aggregate as percent total volume of specimen.

The volumetric proportions of the sample will

$$\% V_v = 100 - 13.7 - 82.6 = 3.7\%$$

$$\% \text{ Agg. Voids} = 100 - 82.6 = 17.4\%$$

$$\% \text{ Agg. Voids filled with asphalt} = \frac{13.7}{17.4} = 78.7\%$$

Comparison of Proportions by Weight and Proportions by Volume for Sample Briquette

Constituent Material		Proportions by Weight	Proportions by Volume
Asphalt	..	6.0%	13.7%
Coarse Aggregate	..	52.0%	46.8%
Fine Aggregate	..	34.6%	29.5%
Mineral Filler	..	7.4%	6.3%
Total Aggregate	..	94.0%	82.6%

Compared with the design requirements (volumetric) shown in figure on page 153, it will be seen that the characteristics of this sample briquette falls within the desired limits. The percent air voids of 3.7% are within the range of 3 to 5 percent, the aggregate occupies 82.6% per cent of the volume leaving asphalt to occupy 13.7 percent of the volume compared with the minimum of 10 per cent specified.

A paving mix designed and laid to the above proportions will give sufficient durability by provision of an adequate quantity of asphalt. It will have sufficient air voids to provide the required reservoir of space for expansion and at the same time produce a waterproof pavement which will neither bleed nor unravel. A mix with these characteristics, normally has sufficient workability for placement in the field. Normally, it will also provide sufficient stability but for a complete and proper design it is essential to determine this factor by one of the Mix Design Methods mentioned on page 156. Due to limitations of space it is not our intention to describe all the various approved Mix Design Methods but detailed information on this will be available on application to the nearest Stanvac office.

Based on the Classification of Hot-Mix Asphalt Paving given in figure on page 151 the following eight charts give the composition of each type of mix. They give the range of aggregate gradation and the range of normal asphalt content. Somewhere within these ranges will be a mix of each respective type which will give the maximum durability with sufficient stability and air voids. For proper design, a complete analysis is recommended for which laboratory facilities are essential. These charts are therefore a general guide for composition of paving mixes.

# COMPOSITION OF TYPE I MIX

## (Macadam Type)

Mix No.	Ia
Recommended Use	Base
Compacted Depth Recommended for Individual Courses	3 in.—4 in.
Sieve Sizes (Square Openings)	Percent Passing By Weight
2½ in.	100
1½ in.	35—70
1 in.	—
¾ in.	0—15
½ in.	—
⅜ in.	—
# 4	—
# 8	0—5
# 30	—
# 100	—
# 200	0—3

Normal asphalt content 3.0—4.5% by weight of total mix.  
Upper limit may be raised when using absorptive aggregate.

Traffic Limitations: None.

Surface Texture: Very open and porous (requires surface course).

Aggregate Required: Hard, sound, angular crushed stone, gravel, slag and fine aggregate.

Stability: Good.

Flexibility: Excellent.

## COMPOSITION OF TYPE II MIXES (Open Graded)

Mix No.	IIa	IIb	IIc	IIId	IIIf
Recommended Use	Mix Seal	Surface or Mix Seal	Surface or Binder	Binder or Base	Binder or Base
Compacted Depth Recommended for Individual Courses	$\frac{3}{8}$ in.— $\frac{1}{2}$ in.	$\frac{1}{2}$ in.— $1\frac{1}{2}$ in.	1 in.—2 in.	$1\frac{1}{2}$ in.—3 in.	3 in.—4 in.
Sieve Sizes (Square Openings)	Percent Passing By Weight				
$1\frac{1}{2}$ in.					100
1 in.				100	70—100
$\frac{3}{4}$ in.			100	70—100	50—80
$\frac{1}{2}$ in.		100	70—100	—	—
$\frac{3}{8}$ in.	100	70—100	45—75	35—60	25—50
# 4	40—85	20—40	20—40	15—35	10—30
# 8	5—20	5—20	5—20	5—20	5—20
# 30	—	—	—	—	—
# 100	—	—	—	—	—
# 200	0—4	0—4	0—4	0—4	0—4

Normal asphalt content 3.0—6.0% by weight of total mix.  
Upper limit may be raised when using absorptive aggregate.

Traffic Limitations: None.

Surface Texture: Open.

Aggregate Required: Hard, sound, angular crushed stone, gravel, slag and fine aggregate.

## COMPOSITION OF TYPE III MIXES (Coarse Graded)

Mix No.	IIIa	IIIb	IIIc	IIId	IIIE
Recommended Use	Surface	Surface, Leveling, or Binder	Binder	Binder or Base	Binder or Base
Compacted Depth Recommended for Individual Courses	¾ in.—1½ in.	1 in.—2 in.	1 in.—2 in.	1½ in.—3 in.	3 in.—4 in.
Sieve Sizes (Square Openings)	Percent Passing By Weight				
1½ in.					100
1 in.				100	75—100
¾ in.		100	100	75—100	60—85
½ in.	100	75—100	75—100	—	—
⅜ in.	75—100	60—85	60—85	45—70	40—65
# 4	35—55	35—55	30—50	30—50	30—50
# 8	20—35	20—35	20—35	20—35	20—35
# 30	10—22	10—22	5—20	5—20	5—20
# 50	6—16	6—16	3—12	3—12	3—12
# 100	4—12	4—12	2—8	2—8	2—8
# 200	2—8	2—8	0—4	0—4	0—4

Normal asphalt content 4.5—6.0% by weight of total mix.

Upper limit may be raised when using absorptive aggregate.

Traffic Limitations: None.

Surface Texture: Open—medium to coarse.

Aggregate Required: Hard, sound, angular crushed stone, gravel, slag and fine aggregate.

# COMPOSITION OF TYPE IV MIXES

## (Dense Graded)

Mix No.	IVa	IVb	IVc	IVd
Recommended Use	Surface	Surface	Surface or Binder	Binder or Base
Compacted Depth Recommended for Individual Courses	3/4 in. — 1½ in.	1 in. — 2 in.	1½ in. — 2 ½ in.	2 in. — 3 in.
Sieve Sizes (Square Openings)	Percent Passing By Weight			
1 ½ in				100
1 in			100	80 - 100
3/4 in		100	80 - 100	70 - 90
1/2 in	100	80 - 100	—	—
3/8 in	80 - 100	70 - 90	60 - 80	55 - 75
# 4	55 - 75	50 - 70	48 - 65	45 - 62
# 8	35 - 50	35 - 50	35 - 50	35 - 50
# 30	18 - 29	18 - 29	19 - 30	19 - 30
# 50	13 - 23	13 - 23	13 - 23	13 - 23
# 100	8 - 16	8 - 16	7 - 15	7 - 15
# 200	4 - 16	4 - 10	0 - 8	0 - 8

Normal asphalt content 3.5—7.0% by weight of total mix.

Upper limit may be raised when using absorptive aggregate.

Traffic Limitations: None.

Surface Texture: Medium to fine.

Aggregate Required: Hard, sound, angular crushed stone, gravel, slag, and fine aggregate.

# COMPOSITION OF TYPE V MIXES

## (Fine Graded)

Mix No.	Va	Vb*
Recommended Use	Surface	Surface of Leveling
Compacted Depth Recommended for Individual Courses	3/4 in.—1½ in.	1 in.—2 in.
Sieve Sizes (Square Openings)	Percent Passing By Weight	
3/4 in.	—	100
1/2 in.	100	85 - 100
3/8 in.	85 - 100	—
# 4	65 - 80	65 - 80
# 8	50 - 65	50 - 65
# 30	25 - 40	25 - 40
# 100	10 - 20	10 - 20
# 200	3 - 10	3 - 10

Normal asphalt content 4.0—7.5% by weight of total mix.

Upper limit may be raised when using absorptive aggregate.

### Suggested Applications:

**Surface:** General utility mix. Often used for streets and highways, driveways, parking lots, and playgrounds. Widely used where coarse aggregates are scarce or expensive.

**Leveling:** For leveling of uneven bases.

**Traffic Limitations:** For very heavy traffic, the finer grades of the mix type tend to be somewhat sensitive to variations in proportioning and may become critical. Thorough laboratory testing before being used for very heavy traffic.

**Surface Texture:** Dense and gritty.

**Aggregate Required:** Hard, sound, angular crushed stone, gravel, slag and fine aggregate.

\*May be used for base where coarse aggregate is not economically available.

## COMPOSITION OF TYPE VI MIXES

### (Stone Sheet)

Mix No.	VIa	VIb*
Recommended Use	Surface	Surface, Leveling
Compacted Depth Recommended for Individual Courses	1 in.—2 in.	1 in.—2 in.
Sieve Sizes (Square Openings)	Percent Passing By Weight	
3/4 in.		100
1/2 in.	100	—
3/8 in.	85 – 100	85 – 100
# 4	—	—
# 8	65 – 80	65 – 80
# 16	50 – 70	47 – 68
# 30	35 – 60	30 – 55
# 50	25 – 48	20 – 40
# 100	15 – 30	10 – 25
# 200	6 – 12	3 – 8

Normal asphalt content 4.5—8.5% by weight of total mix.  
Upper limit may be raised when using absorptive aggregate.

#### Suggested applications:

**Surface:** For city streets, playgrounds, tennis and game courts, and industrial floors. Used for roads where coarse aggregates are scarce or expensive.

**Leveling:** Commonly used.

**Traffic Limitations:** None.

**Surface Texture:** Dense and gritty.

**Aggregate Required:** Well graded. Moderately sharp to sharp sands are preferable.

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\*May be used for base where coarse aggregate is not economically available.

# COMPOSITION OF TYPE VII MIXES

## (Sand Sheet)

Mix No.	VIIa*
Recommended Use	Surface
Compacted Depth Recommended for Individual Courses	1/2 in.—1 in.
Sieve Sizes (Square Openings)	Percent Passing By Weight
3/8 in.	100
# 4	85 – 100
# 8	80 – 95
# 16	70 – 89
# 30	55 – 80
# 50	30 – 60
# 100	10 – 35
# 200	4 – 14

Normal asphalt content 7.0—11.0% by weight of total mix.

Upper limit may be raised when using absorptive aggregate.

**Suggested Applications:** As a surface on city streets and highways where aggregates are not economically available.

**Aggregate Required:** Well graded. Moderately sharp to sharp sand preferable.

**Surface Texture:** Dense and gritty.

\*May be used for base where coarse aggregate is not economically available.

# COMPOSITION OF TYPE VIII MIXES

## (Fine Sheet)

Mix No.	VIIIa
Recommended Use	Surface
Compacted Depth Recommended for Individual Courses	$\frac{1}{2}$ in.—1 $\frac{1}{2}$ in.
Sieve Sizes (Square Openings)	Percent Passing By Weight
# 4	100
# 8	95 - 100
# 16	85 - 98
# 30	70 - 95
# 50	40 - 75
# 100	20 - 40
# 200	9 - 16

Normal asphalt content 7.5—12.0% by weight of total mix.

Upper limit may be raised when using absorptive aggregate.

Suggested Application: City streets.

Surface Texture: Dense and gritty (sand paper).

Aggregate Required: Well graded, sharp sand with inherent stability.



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## **OTHER ASPHALT SURFACES**

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- AIRPORT SURFACING AND  
MAINTENANCE
- ● THIN PREMIX TREATMENT WITH  
SOCOFIX (COLD PROCESS)
- ● ● TENNIS COURTS  
PLAYGROUNDS  
FOOTPATHS  
ESTATE ROADS AND  
DRIVEWAYS  
STATION PLATFORMS

## **AIRPORT SURFACING AND MAINTENANCE**

**DRAINAGE:** This section on airport is not intended to cover any part of airport design other than the wearing surface on the runways and taxi strips. Drainage, of course is of foremost importance and the most costly and highest type of surfacing will not give satisfactory performance unless adequate drainage is provided. The first essential step, therefore, is to develop a dry subgrade through a proper drainage system, and carefully grade it, before any further runway or taxi strip construction is considered. If there is any question as to division of funds it is preferable to provide a low cost surface treatment on a properly drained base, which can be added to and improved upon later, rather than to neglect drainage in favour of a high type wearing surface.

**CHOICE OF SPECIFICATIONS:** The choice of a specification for surfacing a runway or taxi strip will follow much the same line of reasoning used in selecting a specification for surfacing a highway and your attention is invited to pages 31 to 37. The same specifications used for highway surfacing are equally suitable for surfacing runways and taxi strips but, generally speaking, and because of the lesser traffic on runways and taxi strips, a somewhat greater percentage of asphalt is desirable to provide maximum durability.

**PENETRATION MACADAM:** For this reason, and because of the greater percentage of asphalt involved in its use, our first recommendation where a thick wearing surface is considered necessary is a Penetration Macadam surface course laid to the specification on page 114.

Furthermore, it should be noted that no mixing equipment of any kind is required for this type of construction.

**PREMIXES:** If it is decided to surface with a premix any of the premix specifications contained in this book will be satisfactory and the choice will depend on

local conditions. Slightly greater percentages (5% to 10%) of asphalt are recommended than when surfacing a highway with the same specification but in all other respects the procedures are identical.

**SURFACE PAINTING:** Surface dressings are sometimes used for providing the wearing surface on airport runways and taxi strips or for resurfacing them, but where specifications of this type are adopted great care should be used to proportion the bitumen and aggregate correctly and to be sure that all of the aggregate is taken up by the asphalt while the work is in progress. Loose aggregate on the surface of a runway is highly undesirable as it can be whipped around by propeller blast and is therefore a possible source of damage to the fuselage of planes. All loose aggregate should therefore be swept up and removed from the surface. Since this step is necessary it is important to see that the correct quantity of asphalt is used in the first instance as, if an excess is used it is sure to lead to eventual bleeding since there will be no excess aggregate on the surface to absorb it.

**SURFACE PAINTING WITH PREMIXED COVER COAT:** An additional specification not covered under the highway section, and one that is particularly suitable for resurfacing airport runways and taxi strips developed by Standard-Vacuum for that purpose, is what is known as "Thin Premix Treatment with Socofix". This specification is described on the following pages and offers many distinct advantages where the requirements are a seal coat over an existing surface, with or without corrections to grade and camber, and with normal traffic maintained in the runway while the resurfacing is in progress. No heating equipment is required and, if necessary, all mixing can be done by hand. A roller is therefore the only form of construction equipment, other than haulage units, required on the runway. It should be noted that with this specification there will be absolutely no loose aggregate on the surface of the runway.

# THIN PREMIX TREATMENT WITH SOCOFIX

## (Cold Process)

**A. GENERAL DESCRIPTION:** This specification provides for the resurfacing of a bituminous surface with a thin premix laid to a thickness of  $\frac{1}{4}$ " to  $\frac{1}{2}$ " (6 to 12 mm.) according to conditions and to instruction of the Engineer-in-Charge. It is suitable for airport runway resurfacing and for surfacing and resurfacing tennis courts and playground areas.

## B. MATERIALS REQUIRED:

### 1. Asphalt:

- (a) Levelling Depressions – See page 107.
- (b) Tack Coat – Socofix at 10 to 15 lbs. per 100 sq. ft. (490 to 735 kg. per 1000 sq.m.)
- (c) Cover Coat – Socofix at 5 to 10 lbs. per cu. ft. (80 to 160 kg. per cu.m.) of sand and 4 to 5 lbs. per cu.ft. (64 to 80 kg. per cu.m.) of chips.

### 2. Aggregates:

- (a) Levelling Depressions – See page 107.
- (b) Cover Coat – For  $\frac{1}{4}$ " (6 mm.) treatment medium to coarse sand premixed with Socofix and spread at the rate of 3 cu.ft. per 100 sq. ft. (9 cu.m. per 1000 sq.m.)

For  $\frac{1}{2}$ " (12 mm.) treatment  $\frac{1}{4}$ " (6 mm.) chips and medium to coarse sand in equal proportion premixed with Socofix and spread at the rate of 6 cu.ft. per 100 sq. ft. (18 cu.m. per 1000 sq.m.)

Requirements of average conditions excluding Tack Coat and levelling depressions:

	Per 100 sq. ft.		Per 1000 sq.m.	
	$\frac{1}{4}$ "	$\frac{1}{2}$ "	6 mm.	12 mm.
Socofix	30-35 lbs.	45-50 lbs.	1465 to 1710 Kg.	2200 to 2440 Kg.
Sand	3 cu.ft.	3 cu.ft.	9 cu.m.	9 cu.m.
$\frac{1}{4}$ " Chips	—	3 cu.ft.	—	9 cu.m.

### C. LABOUR REQUIRED:

Labourer days	3/5	1	65	108
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### D. EQUIPMENT REQUIRED:

Roller

Mixer-Power driven Pug Mill type if available.

Small Tools (page 61)

Lorries - See Footnote.

### E. ESTIMATED COST COMPLETE:

(Excluding Tack Coat & Levelling)

Rs. 9	Rs. 15	Rs. 970	Rs. 1615
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**F. PROCEDURE:** At least 24 hours and preferably one week in advance of applying the Socofix surface treatment all cracks should be repaired, and in case of cement concrete all joints between the concrete slabs should be filled by the procedures described on page 201. All pot-holes should be repaired and all depressions levelled by the procedures as described on page 107.

1. Brush the surface clean (page 62).
2. Apply Tack Coat with Socofix by means of a sprayer or kerosene tin distributors (page 214); the Socofix should be used without heating.
3. Brush Socofix to uniform coverage with bass brooms.

4. Cover with premix at the rate specified by the Engineer-in-Charge. The premix should be prepared 1 to 3 days in advance.
5. Rake to a uniform level.
6. Roll the surface with power roller.
7. Check with a straight edge during rolling and add or remove premix as required. If any surface voids appear hand pack them with the fine particles of the Sand/Socofix premix.
8. Where this specification is used for airport runway resurfacing it is recommended that the surface be patrolled periodically (once or twice a month) with a rubber tyred roller.

**NOTE: LABOUR:** The above estimates are based on the assumption that mechanically driven Pug Mill type mixers will be used to prepare the premix. If it is necessary to prepare the premix by hand or in drum mixers the labour requirements will be 50 % additional.

**LORRIES:** Where this specification is used for surfacing airport runways that must be kept open to normal traffic throughout, four lorries should be on the job daily. Rather than dump the premix in piles it should be shovelled from the lorries onto the surface and spread out at once so that it will be possible to clear the runway for a plane to land at a short notice. Two lorries should always be on the job so that all small tools can be gathered up and removed immediately when necessary.

## TENNIS COURTS

Asphalt surfaced tennis courts are generally fast and if carefully constructed present a very true playing surface. If properly drained they are usually available for playing on very soon after a rain and are therefore particularly suited to tropical conditions. Enquiries are frequently received not only for recommendations for the asphalt surfacing of tennis courts, but with respect to the layout and base constructions also and the following recommendations are accordingly offered:

**1. Drainage:** Proper drainage is of foremost importance in the construction of a good tennis court. If funds are limited it is always better to construct a low cost surface than to neglect the foundation and drainage. In sandy or gravelly soil under drainage may not always be required, but a good precaution always is to dig a ditch entirely around the court, with such bottom slope and outlet as may be required, and in heavy clay soils this step is recommended as essential. The ditch should be 2 to 3 feet (60 to 90 cm.) in depth, with a perforated corrugated iron pipe, or gun clay tile at the bottom and should then be backfilled with broken stone or coarse gravel to within a few inches of the surface. As the asphalt surface will be impervious to water, surface drainage will be obtained by finishing to a suitable gradient.

**2. Layout:** The surfaced area of a tennis court should be 60 by 120 feet to provide ample room for play beyond the actual limits of a double court measuring 36 feet by 78 feet.

It is preferable to have the entire surface in one plane and the usual gradient is one inch in 10 feet, thus making one end of the court one foot lower than the other.

Where topography makes this impracticable it is satisfactory to have the court slope each way from the net so that each end is 6 inches lower than the centre.

**3. Subgrade:** Before construction is commenced the subgrade should be levelled to conform to the final contour decided upon and should be finished to such an elevation that when the base course and wearing surface are placed and consolidated the finished surface will be slightly above the surrounding area (about  $\frac{1}{2}$ "). If fill is required to bring the subgrade to the required level it should be compacted thoroughly and preferably subjected to several heavy rains before the base course is placed.

**4. Base Course:** For the base course good quality steam cinders are satisfactory, and a compacted depth of 4 to 6 inches will usually be sufficient. Where stone metal, broken brick or gravel base courses are constructed, it is desirable to first place a layer of screenings or sand, so as to consolidate and harden the subgrade and prevent the infiltration of earth into the coarse material. A one-inch depth of screenings or sand well worked into the earth will be sufficient for 3 to 6 inches compacted depth of stone metal, broken brick or gravel, thoroughly and uniformly consolidated by wet rolling with a 5 to 8 ton 3 wheel roller.

**5. Wearing Surface:** One of the specifications listed in the index on pages 1 and 2 will be satisfactory for the wearing surface but the specification contained on page 133 or 136 laid to a depth of 1" is recommended for average conditions. In the case of new constructions the base should always be primed according to the specification on pages 81 and 82 before laying the wearing surface.

**6. Resurfacing:** Very often a low cost reviver coat according to the specification on page 97 or with

Socofix according to the specification on pages 99 and 100 is all that is required. A very useful re-surfacing specification however, and one that affords an opportunity to completely correct any defects in level, is that providing for a Sand/Socofix premixed carpet according to the specification on pages 184 and 185.

## **PLAYGROUND AREAS:**

The recommendations in the previous section for tennis courts are equally applicable to playground areas.

## **FOOTPATHS:**

Footpaths may be likened to roads and consequently any of the specifications listed in the index on pages 1 and 2 are satisfactory for the wearing surface, but since they carry relatively light traffic heavy carpets are of course rarely required. An extremely useful specification because of its ease of application and low cost is that providing for a surface treatment with Liquid Asphalt No. 2 according to the specification on pages 83 and 84. This specification produces a very satisfactory surface and it can be easily maintained at low cost by the procedure described on page 97, but where a higher type surface is required  $\frac{3}{4}$ " or 1" premix is recommended. This specification is listed in the index on pages 1 and 2 the choice will depend on local conditions and, the nature of the local aggregate.

## **ESTATE ROADS AND PRIVATE DRIVEWAYS:**

Here again any of the road surfacing specification listed in the index on pages 1 and 2 will be satisfactory, but because of the relatively light traffic heavy carpets are rarely required. The specification contained on pages 83 and 84 is recommended because of its ease of application and low cost and for average Estate Road

and Private Driveway conditions this specification will provide a very satisfactory and dustless wearing surface. In fact greater attention should be given to the base as, if the base is carefully constructed to proper grade and camber, and well and uniformly consolidated, the specification on pages 83 and 84 followed at intervals as required (1 to 5 years) with the specification on page 97, will provide a very satisfactory wearing surface for which local labour and materials, with the exception of the asphalt binder (Liquid Asphalt No. 2), can be used throughout.

### **STATION PLATFORMS:**

Any of the specifications for road surfacing listed in the index on pages 1 and 2 will be satisfactory and the choice depends upon the funds available. Perhaps the most generally useful specification of surfacing station platforms is the 1" Sheet Macadam specification which consists of a 1" premixed Macadam Course laid to the Procedure on pages 133, and 134, finished with a premixed sand seal coat to the procedure on pages 128 and 129.

This specification is particularly advantageous as all materials are used cold and mixing can be done by hand. The premix should be rolled with a power roller if available, but a hand roller can be used where necessary.

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**ASPHALT FOR INDUSTRIAL PURPOSES  
AND  
WATERPROOFING**

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- MASTIC FLOORING  
OTHER FLOORINGS
- ● ASPHALTS FOR WATERPROOFING
  - Mastic Roofing
  - Leakfix for roof waterproofing
  - Waterproofing Reservoirs
  - Membrane waterproofing
  - Damp Proof Courses
  - Damp Proofing with Plaster Bond.
- ● ● JOINT FILLING
  - Expansion Joints
  - Pipe Joints
- ● ● ● PIPE DIPS
  - REFRIGERATION INSULATION
  - MISCELLANEOUS USES
    - Paints
    - Waterproof Papers
    - Roofing Shingles.

## ASPHALT FOR INDUSTRIAL PURPOSES

**MASTIC FLOORING:** Mastic consists of a mixture of Stanvac Industrial Asphalt with sand, and for severe traffic conditions a certain proportion of stone chips and cement are added. Mastic is ideal as a flooring material in Workshops, Godowns, Station Platforms etc. It is laid in a continuous sheet and is therefore jointless and absolutely hygienic. There is no danger of cracking or breaking away at joints as in the case of cement or patent stone floors, and the finished surface is completely non-absorbent, besides being resilient and dust proof.

Asphalt Mastic can effectively stand the action of dilute acids and alkalies. However in such situations the aggregates and particularly the sand should be carefully selected to exclude all matter likely to be affected by acids and alkalies.

Mastic may be laid over stone, concrete or wooden floors, either indoors or out in the sun, and the mixture varied to suit all conditions of traffic or climate. Stanvac Industrial Asphalt 116 or 20/25 is usually used unless traffic or climatic conditions are unusually severe, in which case the harder grade Stanvac Industrial Asphalt 118 or 10/20 is more suitable. Mixtures lie within the following limits by weight.

### Stanvac Industrial Asphalt

116 or 20/25 .. .. .	15 % to 20 %
Filler (cement or limestone dust) ..	15 % to 20 %
Sand .. .. .	40 % to 50 %
Gravel or Chips $\frac{3}{8}$ "- $\frac{1}{2}$ " (10 to 3 mm.)	25 % to 35 %

The function of the filler is merely to fill the final voids in the sand and it has no hydraulic action. Cement

is usually used, however, on account of its uniform fineness. The sand should be such that it will all pass a 10-mesh sieve and at least 50% pass a 50-mesh sieve.

The best way of preparing a mastic mixture is to use ordinary 45-gallon oil drums cut in two longitudinally and mounted in such a way that they may be fired from underneath. The aggregate is weighed out so that the final batch in each half drum will be 250-300 lbs. (120 to 140 kg.) and it is then heated to a temperature of 350°-400°F (175° to 200°C). The Asphalt is heated in a separate container to the same temperature and then weighed out and mixed with the aggregate by means of shovels, powrahs etc., until the result is a plastic mass.

The hot mastic is shovelled on to the surface to be treated and trowelled out to the desired thickness—usually 1" (2.5 cm.)—wooden battens being used to regulate the thickness. After cooling slightly, the surface is polished by means of wooden floats and a small quantity of fine sand, the final polish being obtained by sprinkling with cement or limestone dust and rubbing vigorously. Succeeding strips should be overlapped a couple of inches before striking off so as to soften up the previous edge and obtain an absolutely clean joint.

The exact proportions of the various ingredients to be used will depend on the nature of the aggregate and its grading, and when in doubt it is recommended that you request further advice from the nearest office of Standard-Vacuum Oil Co. (See page 224) and that you forward samples of aggregate for examination. The following estimates are representative of average conditions:

## B. MATERIALS REQUIRED:

Recommended Batch Proportions	Per 100 sq.ft. 1" thick (5 Batches)	Per 100 sq.m. 2.5 cm. thick
Stanvac Industrial Asphalt 116 or 20/25	39 lbs.	195 lbs. 940 kg.
Mineral Filler	45 lbs.	225 lbs. 1100 kg.
Sand	1½ cu.ft.	6½ cu.ft. 1.9 cu.m.
¾" or ¼" Chips or Gravel	7/10 cu.ft.	3½ cu.ft. 1.05 cu.m.

## C. LABOUR REQUIRED:

Labourer days	4	43
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## D. EQUIPMENT REQUIRED:

Heaters—Half cut oil drums  
Small Tools—Buckets, shovels, powrahs,  
wooden floats, rakes.

## E. ESTIMATED COST

COMPLETE: . . Rs. 75 Rs. 820

NOTE: For floorings which are required to be acid resistant it is necessary that the filler and aggregate should both be acid proof.

**OTHER FLOORING:** Any of the specifications listed on pages 1 and 2 will make suitable flooring but generally speaking the surface treatment type should be avoided because of the loose aggregate on the surface. However, if the flooring is required in a godown in which foodstuffs are to be stored and if any of the cutback specifications are adopted work should be completed well in advance to allow the volatiles to escape and avoid possible contamination of the food.

## ASPHALTS FOR WATERPROOFING

**MASTIC ROOFING:** Mastic laid as described on the previous page to a thickness of  $\frac{1}{2}$ " to  $\frac{3}{4}$ " (12 mm. to 2 cm.) makes an excellent and durable waterproofing for flat or sloping roof decks. It is particularly useful where the roof is subjected to traffic.

The mixture should be slightly richer in Asphalt than that used for flooring, i.e. the Asphalt content should be raised to at least 25 %, and the filler may be omitted. It is also desirable to make provision for expansion and contraction of the roof slab and this is done by laying the mastic over building paper so that it is not all bonded to the roof. For a width of 18" (45 cm.) at each edge, the roof should be thoroughly cleaned and treated with concrete primer so that a bond is obtained all the way round. A few holes about 6" (15 cm.) in diameter should be cut in the building paper at intervals of 8" (20 cm.), and also treated with concrete primer so that at these points the mastic will adhere firmly to the roof.

This type of roofing is practically everlasting, and all the attention it requires is an occasional very thin painting with Liquid Asphalt No. 2 or Leakfix which will liven up the mastic and make it as good as new.

## LEAKFIX FOR ROOF WATERPROOFING.

**Low Cost Dry Weather Roof Repairs:** An application of LEAKFIX applied cold and covered with sand, is an excellent and inexpensive way to waterproof flat concrete or masonry roofs, or flat roofs that have been previously waterproofed with asphalt but whereon the asphalt has become dry and 'hungry'. All work should be completed at least one month before the monsoon. If this is not possible then the use of LEAKPROOF is advised. The following is the procedure recommended:

1. Prepare a mixture of sand and LEAKFIX in the proportion of 2 gallons of LEAKFIX to 3 cu. ft. of sand (110 kg. per cu.m.). After the initial mixing with tools mixing should be continued by labourers kneading the mixture with their fingers. The Sand/Leakfix premix should preferably be prepared 3 to 7 days in advance of use.
2. Open up all cracks on the roof surface to a maximum width and depth of  $\frac{1}{2}$ " (12 mm.).
3. Brush the opened up cracks until they are thoroughly clean and then paint the edges with a thin application of LEAKFIX.
4. Fill the prepared cracks with the Sand/Leakfix premix and ram in hard.
5. Brush the entire roof area clean. (page 63).
6. Apply LEAKFIX by means of kerosene tin distributors at  $1\frac{1}{2}$  to 2 gallons per 100 sq. ft. (7 to 9 kg. per 10 sq.m.) [(see page 214 for diagram and instructions for use.) The perforations should be made according to Note B(1).]
7. Brush the LEAKFIX to uniform coverage with bass brooms. (Page 65).
8. 2 to 24 hours later cover with 2 cu. ft. sand per 100 sq.ft. (0.06 cu.m. per 10 sq.m.). (It is preferable to wait until the following day to apply the sand unless rain threatens).

9. A second application of LEAKFIX one month later is desirable but not always necessary. If this is applied the excess loose sand should be brushed from the surface and then LEAKFIX should be applied at 1 to  $1\frac{1}{2}$  gallons per 100 sq. ft. and covered with  $1\frac{1}{2}$  cu. ft. of sand (4.8 to 7 kg. per 10 sq.m. of LEAKFIX covered with 0.04 cu.m. of sand).

## **LEAKPROOF FOR ROOF WATERPROOFING.**

**Low Cost Wet Weather Roof Repairs:** The procedure described above involving the use of LEAKFIX is to be preferred as LEAKFIX will penetrate into the roof structure to a greater extent than will LEAKPROOF, but if repairs are required during the monsoon or with the monsoon approaching, it is preferable to use LEAKPROOF as this material sets hard more quickly. The procedure is the same, except that the LEAKPROOF can be covered with sand as soon as it turns black (10 to 20 minutes). Material requirements and cost will be about the same as when LEAKFIX is used, but the higher limits of LEAKFIX should be provided.

## **WATERPROOFING RESERVOIRS:**

Concrete reservoirs can be easily waterproofed by the use of either Stanvac Industrial Asphalt 116 or Waterproofing Paint. The procedure is as follows:—

1. Dry out thoroughly, using blow lamps if necessary.
2. Apply 2 coats of Concrete Primer at an interval of one hour between coats, using approximately half a gallon per 100 sq. ft. per coat (25 kg. per 100 sq.m.).
3. When the primer is quite dry (1 or 2 hours) apply Stanvac Industrial Asphalt 116 or 20/25 heated to 400°F., at the rate of 30 lbs. per 100 sq. ft. (146 kg. per 100 sq.m.).

or

Apply 2 coats of Waterproofing Paint at the rate of one gallon per 100 sq. ft. (48 kg. per 100 sq.m.) per coat.

This type of waterproofing is extremely successful when applied over surfaces exposed to a fairly constant temperature or humidity. It may be applied also on sloping or vertical walls.

Both Stanvac Industrial Asphalt 116 and our Waterproofing Paint are unaffected by acids, and the treatment of tanks, besides waterproofing them, protects the concrete from disintegration due to acids.

## **MEMBRANE WATERPROOFING:**

This name is given to a fabric reinforced waterproofing, of which there are a number of proprietary brands on the market. It consists of layers of asphalt-impregnated fabric cemented together and coated with Asphalt.

Stanvac Industrial Asphalt 116 or 20/25 is an excellent material for membrane waterproofing and should be so applied that between 25 and 30 lbs. of Asphalt per 100 sq. ft. are used in between each layer.

## **DAMP PROOF COURSES:**

For masonry walls a strip of membrane waterproofing, cut to the desired width, and bedded in plaster, makes an excellent damp proof course.

The membrane in such cases should contain 3 to 5 layers of a felt weighing 14 to 16 lbs. per 100 sq. ft. The felt is supplied in rolls and the method of constructing the membrane is as follows:—

Unroll one roll of felt on to a flat surface and place the second roll at one end in such a way that it may be unrolled over the first one. Starting at that end, mop on Stanvac Industrial Asphalt 116 or 20/25 at a temperature of 350°F., and unroll the second layer of felt on to it while the asphalt is still hot.

Succeeding layers are added in the same way, and a final mopping of Asphalt is given over the final layer. The whole membrane is then turned over, and the bottom layer of felt treated in the same way.

The membrane may now be cut into strips of the desired width, and the edges of each strip should be painted with Stanvac Industrial Asphalt 116 or 20/25 to prevent the possibility of moisture attacking the felt.

Membrane waterproofing should always be carefully bedded in a course of plaster so as to prevent the possibility of damage by the corners of bricks.

### **DAMP PROOFING WITH PLASTER BOND:**

Plaster Bond is a viscous paint, applied cold, which dries out to a sticky, black finish. It is used as a damp proof course on plinths and floors and is an ideal product for use as adhesive for waterproof membranes.

The surface treated must be dry and should be given two coats at the rate of 1 gallon per 100 sq. ft. (4.8 kg. per 10 sq.m.). At least 24 hours should elapse before applying plaster.

## **JOINT FILLING**

For stone set or block pavement, a sand-asphalt mastic is an ideal joint filling material since it remains plastic, and is not liable to chip away. If the joints are very close, they should be raked out and final dust removed by blowing with a tyre pump.

A blow lamp is then run along the joints to heat them up slightly, and a sand-asphalt mastic composed of 1 part Stanvac Industrial Asphalt 116 or 20/25 or Stanvac Paving Asphalt 10/20 to 3 parts of coarse sand, or 2 parts of fine sand, is run into the joints out of a lipped bucket. The materials are heated separately to 350°F–400°F (175° to 200°C) and combined in the manner described under the section on Mastic Flooring. (Page 192).

If the joints are very wide, or the stone has worn badly, it is desirable to use a hard mastic as there is danger of bullock cart wheels pushing out the softer sand asphalt mixture. In such cases the joints should be raked out and prepared as before and then painted with Concrete Primer. A mastic mixture such as that recommended for flooring is then trowelled into the joints and struck off before it cools.

### **EXPANSION JOINTS:**

The sand asphalt mixture specified above makes an excellent material for filling expansion joints in concrete roads, roofs, flooring slabs etc.

### **PIPE JOINTS:**

Unless a really tight joint is obtained in sewage systems, a large proportion of the carrying capacity of the pipe is neutralized by the inflow of surface water through the joints. If Asphalt is used, a completely tight joint which will last indefinitely is obtained.

Stanvac Industrial Asphalt 116 or 20/25 should be used for all pipes either above or below ground, and should be poured into the joints in exactly the same way as a lead filling.

If desired, joints can be poured horizontally by merely placing a thick rope runner round the pipe and plastering it with mud to prevent the Asphalt from adhering to it.

### **PIPE DIPS:**

It is almost the universal practice in the U.S.A. and Europe to treat all metal water and sewage pipes with Asphalt before laying. The Asphalt coating serves a triple purpose in such cases.

Metal pipes (and this refers also to structural steel under certain conditions) are subject to damage by:—

1. Oxidation due to moisture.
2. Acids from soil, animal droppings etc.
3. Electrolysis from stray electric currents or galvanic action.

Asphalt is impervious to all three.

The usual practice is to dip the pipes into hot Stanvac Industrial Asphalt 116 or 20/25 and to leave them immersed for a period of 15 to 30 minutes. The pipes must be very carefully scraped and wire brushed to ensure that the Asphalt coats direct on to metal and not on to intervening rust or scale.

After immersion, the pipes are suspended vertically over the tank and the excess Asphalt allowed to drip back. Occasionally, when a thicker coating is desired, the pipes are rolled in sand or sawdust immediately after dipping, and then redipped after having cooled off.

The same procedure should be followed with the iron troughing now so common on bridge decks. The troughing is attacked from underneath where it is exposed to the elements, and from top by the percolation of water through the concrete filling, etc. Troughs should preferably be dipped twice in order that they may take up a heavy coating of asphalt.

The above remarks apply also to structural steel, and particularly to that portion of it which is buried in the earth and so exposed to acid action.

When it is desired to coat a metal structure by hand, the surface should be thoroughly cleaned of all rust and scale and primed with Concrete Primer or Waterproofing Paint. After the primer is dry hot Stanvac Industrial Asphalt 116 or 20/25 should be applied at the rate of 20 to 30 lbs. per 100 sq. ft. (9 to 15 kg. per 10 sq.m.).

## **REFRIGERATION AND INSULATION:**

Stanvac Industrial Asphalt 116 or 20/25 is an excellent medium for cementing cork insulation to the walls of refrigeration rooms. It can also be used as the bituminous binder in the manufacture of bituminized granulated cork blocks or tiles, but the processes are generally patented and it is not our purpose herein to comment on manufacturing procedure. The product is merely offered as being suitable for this purpose.

Both STANVAC INDUSTRIAL ASPHALT 116 or 20/25 and STANVAC INDUSTRIAL ASPHALT 118 are used for the manufacture of battery boxes and cases but gilsonite, or granulated mineral rubber are preferred by some manufacturers. The processes are highly specialized and again it is not our purpose to comment on them herein.

**Stanvac Industrial Asphalt 116 or 20/25 and 118 are recommended for use in junction boxes of electrical cables and as an insulation over electrical cables and similar situations underground or exposed.**

## **MISCELLANEOUS USES – PAINT MANUFACTURE, MANUFACTURE OF WATERPROOF PAPER, ETC.:**

The industrial uses to which asphalts are put are almost unlimited and to attempt to comment on all would require volumes instead of the limited space herein available. Paint and lacquer manufacture, the manufacture of waterproofing paper, asphalt shingles, felts, acoustical blocks, wall board fuses, etc. are but a few and Standard-Vacuum engineers will be glad to offer such additional information as is available in connection with any problem you may have.

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## **ASPHALT IN HYDRAULICS**

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- EROSION CONTROL
- ● CANAL LININGS
- ● ● ASPHALT JETTIES AND  
GROYNES.

## **ASPHALT IN HYDRAULICS**

### **GENERAL:**

As asphalt is unaffected by water and unlike most other construction materials it can withstand prolonged contact with water containing salts, acids and alkalies, it has been successfully used in Erosion Control, Reservoir and Canal Linings, Jetties and Groynes, etc. The use of asphalt in hydraulic construction dates from earliest recorded history to the present and because of its inherent qualities, promises to become much more widespread in the future. The versatility of asphalt naturally has led to many variations in its use. Some of these methods which have been used successfully include application of liquid asphalts and road oils, cold mixes, pneumatically mixed and applied sand mastics (gunned type), prefabricated mats, buried membranes and soil stabilization. All have merit in their respective fields and are worthy of future investigation and trial. In Western countries, hot-mix, hot-laid asphaltic concrete, through many years of successful performance, has established itself in the field of hydraulic control as a proven method of construction.

### **EROSION CONTROL:**

Where it is intended to control erosion by run-off water or wind and prevention of water seepage is not of importance, a treatment with a liquid asphaltic product is usually found sufficient. Road berms, embankments and cut slopes made of erodible earth may often be satisfactorily protected with a surface treatment of low viscosity medium curing asphalt like Socofix Primer. On sandy structures, slow curing asphaltic products like Liquid Asphalt No. 2 may be used. In all such cases, the application is light, usually not more than 20 lbs. per 100 sq.ft. (1 kg. per sq.m.) so as to penetrate the soil for a depth of about  $\frac{1}{2}$  inch (12 mm.). This treatment holds the soil in place until grass and weed seeds, usually

present in the soil, have an opportunity to germinate and obtain a root hold. The treatment should be given when the soil is slightly moist. The asphalt treatment will assist in retaining the soil moisture and accelerating germination of grass and weed which have no difficulty in breaking through the thin layer of asphalt. Where the soil does not contain any seeds it is impregnated with the seeds of the weed and grass indigenous to the locality.

Run-offs due to floods which may carry considerable amount of abrasives like gravel and boulders and drainage channels which may carry water at high velocities, require relatively heavy asphalt protection to prevent erosion. The same is true of upper bank protection of rivers carrying flood waters. In such cases, penetration macadam (full grout) or premixed macadam treatment is indicated. If hydraulic back pressure is expected, a permeable type of mix is required. The choice of specification, thickness required and the grade of asphalt to be used will depend upon local conditions and availability of materials.

### **CANAL LINING:**

In case of canal linings, prevention of water seepage and weed control are important factors. Various inorganic chemicals and petroleum derivatives have been successfully used to sterilize the soil and control weed growth.

Control of water seepage can be accomplished by several methods. These include cold mixes employing liquid asphalts and road oil, pneumatically mixed and applied sand mastics (gunned type), prefabricated mats, sprayed primes and surface treatments, buried membranes, soil stabilization and asphaltic concrete. All these methods indicate that the inherent versatility of asphalt can be employed with advantage depending upon individual requirements of each situation. Some of these processes are briefly described below:

## **ASPHALT GUNITE:**

This process of comparatively recent origin employs sand, portland cement, emulsified asphalt and water. As the equipment used for application consists of a modified form of conventional "gunite" equipment the entire process has become known as "asphalt gunite". It is pneumatically applied and produces a non-rigid, water-impermeable and erosion-resistant lining. The process calls for about 12 % emulsified asphalt, 3 to 5 % portland cement, about 10 % water and the rest coarse sand. Modification of conventional gunite equipment includes a water ring for adequate mixing in the nozzle and an extra hose line to provide separate sources for the emulsion and the water. The sand and cement mixture is transported to the nozzle through a hose at a pressure of about 60 p.s.i. Water and asphalt emulsion are introduced through separate hose lines each of which is provided with a valve to control the amount of emulsion or water.

## **PREFABRICATED LININGS:**

Prefabricated asphalt panels or reinforced, moulded asphalt panels consist of impermeable asphalt mixes or membranes which are manufactured at a central plant and transported as a finished product to the site of work. They are laid directly upon a prepared sub-grade and the joints sealed with a hot asphalt or cold application asphalt mastic.

## **BURIED MEMBRANES:**

This type of lining consists of a thin sprayed-on layer of asphalt (containing no filler or reinforcing of any nature) covered by some protective material. The primary object of this lining is to obtain a sufficiently thick, continuous asphalt film to provide a completely water tight membrane. The amount of asphalt used will vary with the texture of the material on which it is sprayed.

Asphaltic material used for membrane must be tough enough to withstand mutilation during application. It must also be sufficiently ductile to conform readily to any settlement of the base or sub-grade. For these reasons, steam refined grades like Stanvac Paving Asphalt 30/40 are recommended for these works. Protective covering and base course materials range from earth, sand or gravel to asphaltic concrete, portland cement concrete or portland cement gunite. If of earth, sand or gravel, the protective covering above the membrane may vary from 1 to 3 ft. (30 to 90 cm.) in thickness depending upon the type of cover material and operating conditions. When used in conjunction with asphaltic concrete, portland cement concrete or portland cement gunite, the membrane is usually sprayed between layers of these materials.

### **ASPHALTIC CONCRETE LININGS:**

Good hydraulic linings have to accomplish several objectives. They are installed for the purpose of (a) preventing loss of water in permeable formation, (b) protecting the banks from erosion, (c) lessening of hydraulic friction and (d) reducing future maintenance. To do these things a lining should be tough and durable; it should have mechanical stability and flexibility to adapt itself to minor adjustments in the subgrade; it should be smooth and readily amenable to repair and it must be impermeable. Properly designed and laid asphaltic concrete will satisfy all these requirements. The type of asphaltic concrete mix which most adequately serves all of the above functional demands is a well-graded, dense and rich mix. Such a mix, containing less than 5% voids in the compacted state, may be considered impermeable. The mix should be constructed from a well-graded, sound aggregate not exceeding  $\frac{3}{4}$ " (2cm) maximum size and never greater than one-third the finished thickness of the lining. The mix should be fine graded rather than coarse and should contain the maximum amount of asphalt commensurate with high stabi-

lity. The asphalt used in the mix should be a straight grade sufficiently hard but at the same time ductile to resist the growth of weed, transverse creep, physical damage, and cracking due to settlement of sub-grade. The grade suggested for conditions in India is Stanvac Paving Asphalt 30/40. Thickness of asphaltic concrete linings varies from  $1\frac{1}{2}$  to 3 inches (4 to 8 cm.)

### **ASPHALT JETTIES & GROYNES:**

Asphalt jetties and groynes usually consist of immense windrows of large stones extending into the water for control of erosion by sea. They usually extend for a long distance into the sea with the top only slightly above high water level. A typical cross-section of such a structure is shown below:



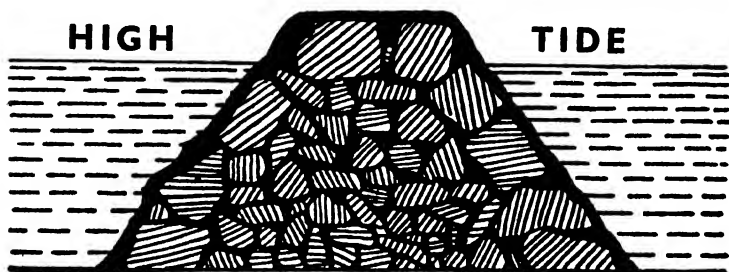
### **Stone Jetty (Cross Section)**

Structures of this type have two serious faults viz.

1. The large voids between the stones permit water, carrying silt and sand, to flow through.
2. The stones are not bonded together and consequently they are often washed away by severe storms.

It has been found that a hot asphalt mixture can be successfully used to grout such structures from the top to a depth of 10 feet (3 metres) or more below the water and that the sides, for depths upto 40 feet (12 metres) or more may be protected by covering them with a coating of asphalt mixture.

The asphalt mixture used for this type of grouting work consist of beach sand and 10 to 20% of asphalt. It is heated to a temperature of approximately 450°F. (232°C.) and dumped on the surface of the structure in large loads using long handled internal vibrators to assist the mixture in flowing into the voids between the stones. When placed in mass and at a high temperature the mixture does not become mixed with water and remains sufficiently hot to permit its flow for a period of approximately 30 minutes after placement. Mixtures so placed have been found to adhere firmly to the stone surfaces. Sufficient quantity of the mixture should be used to cover the structure on all sides as below:



### **Asphalt Filled Jetty**

The grouting mix used for the core of the structure is usually made of a soft grade of paving asphalt with a high asphalt content to obtain maximum penetration of the core. The top and the sides are capped with a leaner mix of a harder asphalt like Stanvac Paving Asphalt 30/40.



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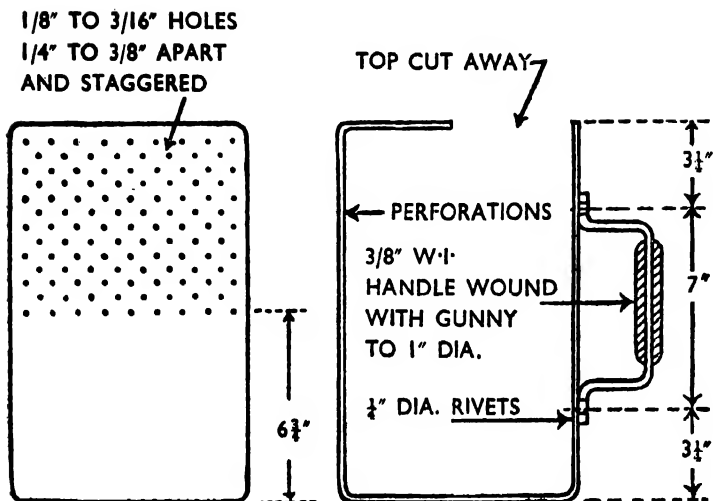
## **USEFUL TABLES & DIAGRAMS**

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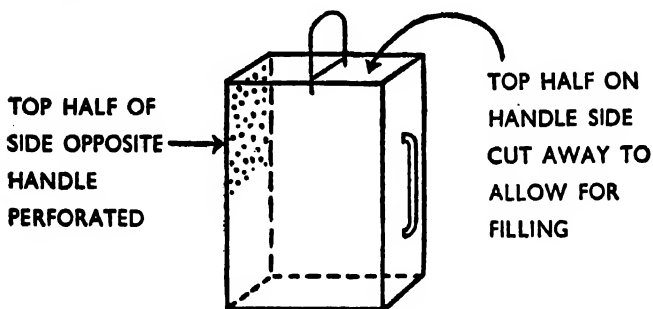


# CUT-BACK DISTRIBUTOR

FOR COLD APPLICATION MATERIALS  
MADE FROM EMPTY 4 GALLON KEROSENE TIN



NOTE—If tin is filled to the bottom line of perforations, contents will be exactly 2 gallons.



## CUTBACK DISTRIBUTOR

NOTE B—To place holes to best advantage use the following procedure:—

- (1) FOR SOCOFIX and LIQUID ASPHALT NO. 2 —

Draw horizontal lines  $\frac{5}{8}$ " apart with the bottom line  $6\frac{3}{4}$ " above the bottom of the tin. Draw vertical lines  $\frac{5}{8}$ " apart. Punch  $3/16$ " holes at each intersection and in the centre of each square.

- (2) FOR SOCOFIX PRIMER —

Draw the lines  $\frac{1}{2}$ " apart and make the holes  $3/32$ " in size.

# EQUIVALENT MEASURES LENGTHS

Inches	Feet	Yards	Rods	Miles	Metric Equivalent
1	0.083333	0.027778	.....	.....	25.4001 mm.
12	1	.33333	.....	.000189394	2.54001 cm.
36	3	1	.....	.000568182	0.304801 m.
198	16.5	5.5	0.181818	.003125	0.914402 m.
63,360	5,280	1,760	320	1	5,029,210 m.
39.37	3,280.83	1,093.61	.....	.....	1.60935 km.
.....	.....	.....	198.838	0.621372	1 m.
					1 km.

1 link = 0.66 foot = 7.92 inches  
 1 rod = 25 links  
 1 furlong = 40 rods = 220 yards = 660 feet  
 1 surveyor's chain = 4 rods = 100 links = 66 feet  
 1 station = 100 feet  
 1 mile = 52.8 stations

# EQUIVALENT MEASURES

## AREAS

Square Inches	Square Feet	Square Yards	Square Rods	Acres	Square Miles	Metric Equivalent
1	.....	.....	.....	.....	.....	6.451626 sq. cm.
144	1	0.111111	.....	.....	.....	0.092903 sq. m.
1,296	9	1	.....	.....	.....	0.836131 sq. m.
.....	272.25	30.25	.....	0.00625	.....	25.29295 sq. m.
.....	43,560	4,840	160	1	0.0015625	4046.873 sq. m.
.....	.....	3,097,600	102,400	640	1	2.589998 sq. km.
.....	10.76387	1.19599	.....	.....	.....	1

- 1 square link = 62.7264 square inches
- 1 square = 100 square feet
- 1 square chain = 16 square rods
- 1 acre = 10 square chains = 4,046.873 square metres
- 1 square acre = 208.71 feet on each side
- 1 section = 1 square mile

# EQUIVALENT MEASURES

## CUBIC VOLUMES

Cubic Inches	Cubic Feet	Cubic Yards	Metric Equivalent
1	0.000578704	.....	16.3872 cu. cm.
1728	1	0.0370370	0.0283170 cu. m.
46656	27	1	0.764559 cu. m.
.....	35,314	1.3079	1 cu. m.

1 board foot = 144 cubic inches  
1 cord = 128 cubic feet

## WEIGHTS—AVOIRDUPOIS

Ounces	Pounds	Short Tons	Long Tons	Metric Equivalent
1	0.0625	.....	.....	28.349527 g.
16	1	0.0005	0.00044643	0.4535924 kg.
32000	2000	1	0.8928571	.9071849 ton
.....	2240	1.12	1	1.01605 tons
.....	2204.622	1.1023112	0.9842064	1 ton

1 short hundredweight (cwt) = 100 pounds = 0.05 short tons = 45.3592 kilograms  
1 long hundredweight = 112 pounds = 0.05 long tons = 50.8023 kilograms

## WEIGHT OF WATER AT 60° F.

1 gallon = 8.337 pounds  
1 cubic foot = 62.372 pounds  
1 cubic yard = 1684.044 pounds

# **I.R.C. STANDARD SIZES FOR AGGREGATES AND THEIR METRIC EQUIVALENTS**

<b>Standard Size</b>	<b>Passing Square Mesh of</b>	<b>Retained on Square Mesh of</b>
2½" (6 cm.)	3" (8 cm.)	2" (5 cm.)
2" (5 cm.)	2½" (6 cm.)	1½" (4 cm.)
1½" (4 cm.)	2" (5 cm.)	1" (2½ cm.)
1" (2½ cm.)	1½" (4 cm.)	¾" (2 cm.)
¾" (2 cm.)	1" (2½ cm.)	½" (12 mm.)
½" (12 mm.)	¾" (2 cm.)	⅜" (10 mm.)
⅜" (10 mm.)	½" (12 mm.)	¼" (6 mm.)
¼" (6 mm.)	⅜" (10 mm.)	⅛" (5 mm.)
Sand	⅛" (5 mm.)	200 Mesh Sieve

# **PRACTICAL CONVERSION OF AGGREGATES & ASPHALT APPLICATIONS**

<b>Cu.ft per 100 Sq.ft.</b>	<b>=</b>	<b>Cu.m. per 1000 Sq. m.</b>	<b>Lb. per 100 Sq.ft.</b>	<b>=</b>	<b>Kg. per 1000 Sq.m.</b>
1 cu. Ft	=	3.05 cu. M.	1 Lb.	=	48.82 Kg.
2 "	=	6.09 "	2 "	=	97.65 "
3 "	=	9.14 "	3 "	=	146.47 "
4 "	=	12.18 "	4 "	=	195.30 "
5 "	=	15.23 "	5 "	=	244.12 "
6 "	=	18.28 "	6 "	=	292.95 "
7 "	=	21.32 "	7 "	=	341.77 "
8 "	=	24.37 "	8 "	=	390.60 "
9 "	=	27.42 "	9 "	=	439.42 "
10 "	=	30.47 "	10 "	=	488.24 "
15 "	=	45.70 "	15 "	=	732.36 "
20 "	=	60.94 "	20 "	=	976.48 "
25 "	=	76.18 "	25 "	=	1220.60 "
30 "	=	91.42 "	30 "	=	1464.72 "
35 "	=	106.65 "	35 "	=	1708.84 "
40 "	=	121.89 "	40 "	=	1952.95 "
45 "	=	137.12 "	45 "	=	2197.08 "
50 "	=	152.36 "	50 "	=	2441.19 "
60 "	=	182.83 "	60 "	=	2929.43 "
70 "	=	213.31 "	70 "	=	3417.67 "
80 "	=	243.78 "	80 "	=	3905.91 "
90 "	=	274.25 "	90 "	=	4394.15 "
100 "	=	304.80 "	100 "	=	4882.41 "

1 Cu.Ft. = 0.0283 Cu.M.      1 Lb. = 0.4536 Kg.  
100 Sq.Ft. = 9.2903 Sq.M.

## Two-Way Temperature Conversion Table

### HOW TO USE IT:

To convert a temperature from  
°C. to °F.—

locate your Centigrade temperature in the center column and read the corresponding Fahrenheit value in the column to the left.

To convert a temperature from  
°F. to °C.—

locate your Fahrenheit temperature in the center column, and read the corresponding Centigrade value in the column to the right.

°F. —	°C	°F. —	°C	°F. —	°C	°F. —	°C
°F	°C	°F	°C	°F	°C	°F	°C
32.0	0	—	17.8	161.6	72	22.2	291.2
35.6	2	—	16.7	165.2	74	23.3	294.8
39.2	4	—	15.6	168.8	76	24.4	298.4
42.8	6	—	14.4	172.4	78	25.6	302.0
46.4	8	—	13.3	176.0	80	26.7	305.6
50.0	10	—	12.2	179.6	82	27.8	309.2
53.6	12	—	11.1	183.2	84	28.9	312.8
57.2	14	—	10.0	186.8	86	30.0	316.4
60.8	16	—	8.9	190.4	88	31.1	320.0
64.4	18	—	7.8	194.0	90	32.2	323.6
68.0	20	—	6.7	197.6	92	33.3	327.2
71.6	22	—	5.6	201.2	94	34.4	330.8
75.2	24	—	4.4	204.8	96	35.6	334.4
78.8	26	—	3.3	208.4	98	36.7	338.0
82.4	28	—	2.2	212.0	100	37.8	341.6
86.0	30	—	1.1	215.6	102	38.9	345.2
89.6	32	—	0	219.2	104	40.0	348.8
93.2	34	+	1.1	222.8	106	41.1	352.4
96.8	36	—	2.2	226.4	108	42.2	356.0
100.4	38	—	3.3	230.0	110	43.3	359.6
104.0	40	—	4.4	233.6	112	44.4	363.2
107.6	42	—	5.6	237.2	114	45.6	366.8
111.2	44	—	6.7	240.8	116	46.7	370.4
114.8	46	—	7.8	244.4	118	47.8	374.0
118.4	48	—	8.9	248.0	120	48.9	377.6
122.0	50	—	10.0	251.6	122	50.0	381.2
125.6	52	—	11.1	255.2	124	51.1	384.8
129.2	54	—	12.2	258.8	126	52.2	388.4
132.8	56	—	13.3	262.4	128	53.3	392.0
136.4	58	—	14.4	266.0	130	54.4	395.6
140.0	60	—	15.6	269.6	132	55.6	399.2
143.6	62	—	16.7	273.2	134	56.7	402.8
147.2	64	—	17.8	276.8	136	57.8	406.4
150.8	66	—	18.9	280.4	138	58.9	410.0
154.4	68	—	20.0	284.0	140	60.0	413.6
158.0	70	—	21.1	287.6	142	61.1	417.2

## CONVERSION TABLE FOR AGGREGATES

Cu. Ft. Per 100 sq. ft.	Equivalent requirements per Furlong for the Road Widths indicated					
	8 Feet	9 Feet	10 Feet	12 Feet	16 Feet	20 Feet
1	53	59	66	79	106	132
2	106	119	132	158	212	264
3	158	178	198	238	316	396
4	211	238	264	317	422	528
5	264	297	330	396	528	660
6	317	356	396	475	634	792
8	422	475	528	634	845	1056
10	528	594	660	792	1056	1320
12	634	713	792	950	1267	1584
14	739	832	924	1109	1478	1848
16	845	950	1056	1267	1689	2112
18	950	1069	1188	1426	1900	2376
20	1056	1188	1320	1584	2112	2640
22	1162	1307	1452	1742	2324	2904
24	1267	1426	1584	1901	2534	3168

## Asphalt Required Per Mile In Long Tons

Asphalt specified lbs./100 sqt.	— ROAD WIDTH —					
	10'	12'	14'	16'	18'	20'
1	0.24	0.28	0.33	0.38	0.42	0.47
2	0.47	0.57	0.66	0.75	0.85	0.94
3	0.71	0.85	0.99	1.13	1.27	1.41
4	0.94	1.13	1.32	1.51	1.70	1.89
5	1.18	1.41	1.65	1.89	2.12	2.36
6	1.41	1.70	1.98	2.26	2.55	2.83
7	1.65	1.98	2.31	2.64	2.97	3.30
8	1.89	2.26	2.64	3.02	3.39	3.77
9	2.12	2.55	2.97	3.39	3.82	4.24
10	2.36	2.83	3.30	3.77	4.24	4.71
15	3.54	4.24	4.95	5.66	6.36	7.07
20	4.71	5.66	6.60	7.54	8.49	9.43
25	5.89	7.07	8.24	9.43	10.61	11.79
30	7.07	8.49	9.90	11.31	12.73	14.14
35	8.25	9.90	11.55	13.20	14.85	16.50
40	9.43	11.31	13.20	15.09	16.97	18.86
45	10.61	12.73	14.85	16.97	19.09	21.21
50	11.79	14.14	16.50	18.86	21.21	23.57
60	14.14	16.97	19.80	22.63	25.46	28.29
70	16.50	19.80	23.10	26.40	29.70	33.00
80	18.86	22.63	26.40	30.17	33.94	37.71
90	21.21	25.46	29.70	33.94	38.19	42.43
100	23.57	28.29	32.00	37.71	42.43	47.14

Add 2% to above quantities to cover wastage.

## **STANDARD-VACUUM OIL COMPANY—Branches.**

- **Standard Vacuum Oil Company,  
Post Box No. 181,  
17, Jamshedji Tata Road,  
Churchgate,  
BOMBAY 1.**
- **Standard-Vacuum Oil Company,  
Post Box No. 146,  
6, Church Lane,  
CALCUTTA 1.**
- **Standard-Vacuum Oil Company,  
Post Box No. 115,  
Bombay Mutual Building,  
Netaji Subhas Chandra Bose Road,  
MADRAS - 1.**
- **Standard-Vacuum Oil Company,  
Post Box No. 255,  
United Commercial Building,  
Parliament Street,  
NEW DELHI.**
- **Standard-Vacuum Oil Company,  
Post Box No. 190,  
Imperial Bank Buildings,  
Baillie Street,  
COLOMBO 1.**
- **Standard-Vacuum Oil Company,  
Post Box No. 331,  
Chartered Bank Building,  
Phayre Street,  
RANGOON.**

**Acknowledgements:**

**Asphalts & Allied Substances, Abraham**

**The Asphalt Institute**

**Dr. N. W. McLeod, Imperial Oil Limited**

**J. Lefebvre, Imperial Oil Limited.**

